Tenth Biennial Report on Great Lakes Water Quality

July 2000

International Joint Commission

Commission mixte internationale

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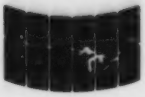

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June 29, 2000

Open Letter to Great Lakes Leaders and the Great Lakes Community

In 1978, the United States and Canadian governments made an historic commitment to restoring the water quality of the Great Lakes. The Great Lakes Water Quality Agreement calls for the restoration and maintenance of the integrity of the waters of the Great Lakes basin ecosystem.

The power of the vision captured in the Agreement has not been reflected in the two governments' implementation efforts. Although progress has been made, Governments have not committed adequate funding or taken the decisive actions required to restore and protect the Great Lakes. Much more must be done to ensure that citizens of both countries can safely swim in and drink water and eat fish from the Great Lakes.

The integrity of the Great Lakes ecosystem has been and continues to be compromised. Contaminated sediments in the lakes produce health problems. Although point-source emissions of toxic substances within the Great Lakes basin have been reduced in some measure, significant amounts of these contaminants are reaching the lakes through the air from places within and far beyond the basin.

Drinking water must be extensively treated. Swimming must often be prohibited and beaches closed. Fish in the Great Lakes are contaminated with persistent toxic substances, including mercury and PCBs. These fish pose a threat to the health of those who eat them and to their unborn children.

Increasing urbanization is adversely affecting water quality. As a result of human activities, alien invasive species are entering the lakes and causing billions of dollars in damages and massive aquatic ecosystem disruption.

Moreover, the public lacks the information to identify sources of contamination, or judge the adequacy of remedial and preventive programs. These problems are not new. Indeed, the Commission and the governments have been aware of many of them for almost a quarter century.

Now is the time for the governments to act to fulfill the terms and spirit of the Agreement, and to take coordinated action in the key areas of human health, general ecosystem health, and accountability. Without such action, which requires the provision of adequate resources for Great Lakes Water Quality Agreement programs, there can be little hope of fully restoring and protecting the Great Lakes.

Contaminated Sediment

The major issue in many of the 42 toxic hot spots in the Great Lakes basin is how to clean up sediments that contain persistent toxic substances. These sediments pose a continuing threat to human health, to the ecosystems of Areas of Concern, and to the Great Lakes ecosystem generally. The Commission believes that actions required for dealing with contaminated sediment in Great Lake communities are proceeding far too slowly due to inadequate funding.

Governments must jointly and publicly commit themselves to a long-term clean-up strategy that projects costs and time frames to achieve the restoration of beneficial uses in Areas of Concern and open-lake waters. Governments must lead by allocating the large amounts of money and other resources that are needed to carry out difficult but essential remedial actions.

Contaminated Sport Fish

Sport fish consumption advisories continue to vary from jurisdiction to jurisdiction and are often difficult to understand. Eating contaminated Great Lakes sport fish is one of the main routes by which humans in the basin are exposed to persistent toxic substances which can cause birth anomalies and other serious health problems. There is strong evidence that pregnant women who eat certain sport fish may have babies who are delayed in their neurological development. The threat tends to affect the most vulnerable in society, those who rely on diets of Great Lakes sport fish and those who do not have access to information about the risks of eating these fish. People must be advised which fish should be totally avoided in the light of the precautionary approach. They must also be advised about how to prepare any fish that may be consumed.

Airborne Toxic Pollutants

Progress has been made in the Great Lakes basin in reducing emissions of persistent toxic substances. Nevertheless, these substances, which threaten the health of the ecosystem, including human health, continue to reach the Great Lakes through the air, coming from well beyond the Great Lakes basin. Without addressing the air transport of persistent toxics, the clean-up of sediments may never be fully achieved. It is now possible, with an atmospheric computer model and adequate emissions data, to link specific distant sources of an airborne pollutant to its deposition in a particular Great Lake. Adoption of this methodology can enable governments to

design control measures to reduce atmospheric deposition of toxic substances to the Great Lakes. These airborne sources should be considered in determining the total pollution load of each lake, in developing lakewide management plans, and in implementing the Great Lakes Binational Toxics Strategy.

Urbanization

Land use in the Great Lakes basin has changed significantly over the past twenty years. In particular, urbanization, which has far-reaching water quality implications, is accelerating rapidly. The impervious surfaces of cities, towns and suburbs increase runoff, which can introduce nutrients, pathogens, sediment, industrial chemicals, and pesticides into waterways. This increased runoff can also exacerbate erosion and the risk of flooding, and pose threats to groundwater. Moreover, urbanization often destroys habitats for fish and wildlife. Although measures have been taken to address these problems in specific locations, governments have not given adequate attention to addressing the general phenomenon of urbanization in the Great Lakes basin.

All levels of government have a role in watershed management and associated land use. Local authorities on their own are not able to approach the issue from the necessary basin-wide perspective. In the light of the accelerating pace at which land in the basin is being turned over to urban and residential use, there is an urgent need for provincial and state governments, with support from the federal governments, to critically reassess the effects of land uses on Great Lakes water quality, and to determine whether responsive measures are required. There is also a clear need to target some of the most ecologically important areas for long-term monitoring and scientific studies. In addition, Great Lakes communities must work to identify and protect critical areas for conservation and public use. Because it is easier to manage development rather than remedy its negative effects, governments should act before the situation deteriorates further.

Alien Invasive Species

Invasions of alien species are irreversible and can disrupt ecosystem integrity. As zebra mussels have shown, when alien invasive species are introduced into the Great Lakes, they can upset the balance of the natural ecosystem, threaten native species, and require the expenditure of many millions of dollars in control and management costs. These invasions are estimated to cause billions of dollars in damages. Alien invasive species may survive in residual sediment in the ballast tanks of vessels and may be flushed into the Great Lakes when such a vessel subsequently takes on and discharges ballast water into the Great Lakes. Alien invasive species may also be introduced when ships, which have transited the St. Lawrence Seaway, discharge their ballast water into the Great Lakes. Other sources of alien invasive species are the baitfish and aquarium trades, and aquaculture has the potential to become one. These also need to be addressed.

There are no easy solutions to the challenge of preventing further introductions of alien invasive species. Existing regulations and guidelines that call for ballast exchange are inadequate to protect the lakes, and exchanging ballast water at sea may put vessels and crews at risk. The Commission continues to believe that there is an immediate need for a clearly defined and coordinated binational research and development program, and for the development of appropriate binational ballast water discharge standards.

Monitoring and Information Management

Without data and information from a full range of sustained and consistent environmental monitoring and surveillance programs, the governments, the public and the Commission are not in a position to identify issues that threaten human and ecosystem health, to choose effective solutions, and to assess whether progress is being achieved. The governments are not undertaking these programs and the Commission cannot fill this gap. With the cuts made to monitoring and surveillance programs in recent years, we are proceeding blind. Even where information is available, public access is sometimes restricted by confidentiality requirements and cost-recovery policies.

In the light of the foregoing, the Commission makes the following recommendations which are among those set out in greater detail in the Commission's Tenth Biennial Report.

Human Health

- Federal, provincial, and state governments should immediately develop a comprehensive binational sediment remediation program, setting priorities and timetables and providing the resources for completion of the program in each Area of Concern.

- The federal governments should identify both in-basin and out-of-basin sources of atmospheric deposition of persistent toxic substances, and use this information to formulate and implement appropriate prevention and control measures. The Great Lakes Binational Toxics Strategy must be strengthened to address fully the treatment of airborne toxic substances.

- Provincial and state governments should require that sport fish consumption advisories state plainly that eating Great Lakes sport fish may lead to birth anomalies and other serious health problems for children and women of childbearing age. These advisories should be addressed and distributed directly to women, in addition to their general distribution. Consumption advisories should clearly identify fish which, in the light of the precautionary approach, should be totally avoided.

General Ecosystem Health

- Federal, provincial and state governments should provide for a binational study of the effects of changes in land use on Great Lakes water quality to determine the measures that should be taken by governments at all levels to control pollution from increasing urbanization and other changes.

- The federal governments should adopt and implement a binational ballast water research strategy and plan, and give a Reference to the Commission to develop binational standards for discharges of ballast water and residual sediments, and the most appropriate methods for implementing those standards.

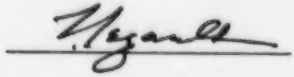
Accountability

- Federal, provincial and state governments should develop and maintain the full range of coordinated monitoring and surveillance programs necessary to enable them to fulfill their commitments under the Great Lakes Water Quality Agreement, and adopt a binational information policy to support implementation of the Great Lakes Water Quality Agreement.

The foregoing proposals are made in coordination with the detailed findings and complete recommendations of the International Joint Commission's Tenth Biennial Report. The full report outlines important steps towards re-launching progress in the implementation of the Agreement.

It is clear that unless the United States and Canadian governments take the actions the Commission now recommends, they will fail to achieve the purpose they set for themselves in 1978: "to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem."

Every delay in achieving this purpose carries a price. With time the price will grow heavier, and the line between delay and outright failure will be stretched thinner. Governments need to show a new sense of urgency and a commitment to action in restoring and protecting the Great Lakes. They must demonstrate this commitment by immediately taking steps to provide the financial and personnel resources to implement the Great Lakes Water Quality Agreement.



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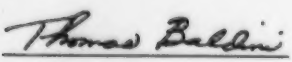

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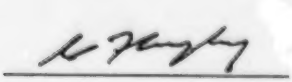

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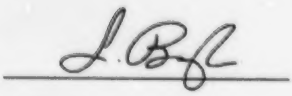

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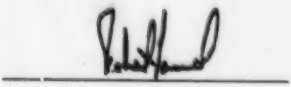

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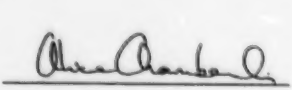

Alice Chamberlin
Commissioner

TENTH BIENNIAL REPORT

Under the Great Lakes Water Quality Agreement of 1978 to the Governments of the United States and Canada and the State and Provincial Governments of the Great Lakes Basin

International Joint Commission, July 2000

Tenth Biennial Report on Great Lakes Water Quality

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10th Biennial Report on Great Lakes Water Quality

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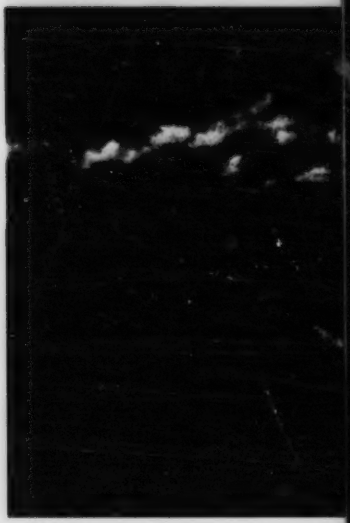


CHAPTER 1
INTRODUCTION

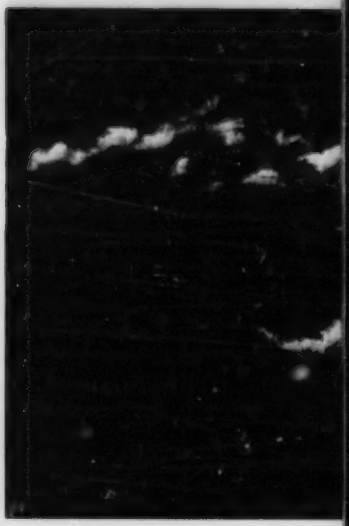
The governments of Canada and the United States ("the Parties") signed the first Great Lakes Water Quality Agreement ("Agreement") in 1972. They concluded the present Agreement in 1978, revised it in 1983 and, in 1987, added new annexes through a Protocol. The Agreement remains one of the most farsighted of international agreements negotiated in modern history. It embraces concepts of ecosystem integrity, pollution prevention and control, remediation, and human health and welfare. These concepts provide a blueprint for future stewardship and enjoyment of the Great Lakes and their associated watersheds and biotic communities. Thirteen years have passed since the addition of the Protocol to the Agreement.

In this Tenth Biennial Report, the International Joint Commission (IJC) assesses the Parties' progress in implementing the Agreement. It addresses several annexes to the Agreement and the Parties' responses to their commitments, in cooperation with state, provincial and other levels of government. The annexes addressed include Annex 2 (Remedial Action Plans and Lakewide Management Plans), Annexes 4, 5, 6, 8 and 9 (The Coast Guard Annexes), Annex 11 (Surveillance and Monitoring), Annex 12 (Persistent Toxic Substances), Annex 13 (Pollution from Nonpoint Sources), Annex 14 (Contaminated Sediment), and Annex 15 (Airborne Toxic Substances).

This report also emphasizes the Parties' binational program responses, which include the State of the Lakes Ecosystem Conferences (SOLEC), the Four Agency Framework, the Great Lakes Binational Toxics Strategy, and the Lake Superior Zero Discharge Demonstration Program. Binational approaches are a challenging aspect of the effort to solve problems in the Great Lakes. Such approaches generally require collective activities and decision-making and depend on cooperation, coordination and joint action. Many of the recommendations contained in this report reflect the need for a sustained level of effort, and their efficacy depends on a significant binational approach and commitment.

Several topics emerged from the review of the annexes and related programs: indicators on environmental conditions of the lakes, impacts of land-use practices, alien invasive species, and information and data management needs. These issues cut across many of the annexes and generated considerable discussion at the 1999 Great Lakes Water Quality Forum in Milwaukee, Wisconsin.

Although it is not the purpose of this report to focus directly on the public comments received at the 1999 Forum in Milwaukee, the many presentations and submissions provide a substantial public record. The Commission has referred to this record in preparing its Tenth Biennial Report and in setting future IJC priorities to be undertaken by the Agreement Advisory Boards and the Council of Great Lakes Research Managers.



CHAPTER 2
RAPS AND LAMPS

2.1 Annex 2 - Remedial Action Plans and Lakewide Management Plans (RAPs and LaMPs)

The 1987 Protocol to the Agreement formalized the concepts of Lakewide Management Plans (LaMPs) for Critical Pollutants in open lake waters and Remedial Action Plans (RAPs) for restoring beneficial uses in Areas of Concern (AOC). RAPs and LaMPs define the actions needed to restore the integrity of the waters of the Great Lakes. Annex 2 outlines stages for planning and implementation and specifies fourteen possible beneficial use impairments in AOCs that would require remediation in the RAPs.

RAP and LaMP processes began officially in 1987. Recently, the Parties have taken steps to accelerate their work. This report addresses two initiatives: a streamlined LaMP process culminating in the LaMP 2000 reports and the Four Agency Framework. This report also addresses the Lake Superior Zero Discharge Demonstration Program, which has been incorporated into the Lake Superior LaMP.

CONCERNS

RAP progress has been slow. Recent staff reductions and budget cutbacks in federal, state, and provincial agencies are frequently cited as obstacles to progress. However, this situation need not result in a lack of implementation, merely slower implementation. Reduced resources could be reflected in schedules showing implementation proceeding as resources

"I think that the public is the real guardian of the Great Lakes Water Quality Agreement. We have put so much effort into ensuring its integrity for 15 years or so."

Manfred Koechlin
Chair, Bay of Quinte PAC

become available. Although the Parties are reluctant to issue schedules, the public has a right to know when they might expect progress toward restoration of beneficial uses. (U.S. Department of State and U.S. Environmental Protection Agency, Great Lakes National Program Office August 1999; Environment Canada 1999)

Planning is important, but it is remedial action flowing from plans that restores beneficial uses. Together with the need for increased levels of resources, progress under Annex 2 will require moving beyond pollution prevention at point sources and will increasingly depend on the remediation of in situ contaminants and the control and management of urban and agricultural nonpoint sources of pollution.

For example, in 1999 the Great Lakes Science Advisory Board advised the Commission that, despite significant improvements in water quality during the past two decades, current concentrations of polychlorinated biphenyls (PCBs) in samples of Great Lakes water are still about 100 times higher than the water quality criteria under the Great Lakes Initiative.[1] (Great Lakes Science Advisory Board 1999) Without sediment cleanup, injury to the health of humans, fish, and wildlife will continue and will impose increasing future costs on both the United States and Canada. A survey of Great Lakes anglers in New York state between 1988 and 1996 revealed that almost half of those surveyed no longer plan to fish in the Great Lakes, citing contaminants in fish as the reason. This decline in fishing, measured by angler-days, is a small example of the cost of inaction. (Connelly, et.al. 1999; Connelly, et.al. 2000)

Status Assessments

In 1996, in response to the perceived slow rate of action on RAP implementation, the Commission instituted a status assessment process in selected AOCs. The purpose is to identify roadblocks to progress with a view to reenergizing remedial action in these areas. To date, the Commission has reported on the Detroit River AOC, the St. Marys River AOC, and the Hamilton Harbour AOC. The Commission also examined examples of successful restoration activities, where these exist, in an effort to share success stories throughout the basin. (IJC 1997a; IJC 1998; IJC 1999a; IJC 1999b)

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1 The Great Lakes Water Quality Initiative was developed under the Great Lakes Critical Programs Act of 1990. The final "Water Quality Guidance for the Great Lakes System" promulgated by the U. S. Environmental Protection Agency established minimum water quality criteria, anti-degradation policies, and implementation procedures as a basis for controlling discharges of toxic pollutants into the Great Lakes system.

Reporting

Annex 2 requires the Parties to develop RAPs and LaMPs in cooperation with the local jurisdictions. These plans are to be submitted at appropriate stages for review and comment by the Commission. The Parties are also to report biennially to the Commission on progress in developing and implementing RAPs and LaMPs and in restoring beneficial uses. Some jurisdictions no longer prepare RAPs by stages, and it appears that the development of LaMPs by stages has already ceased or will cease shortly. This ad hoc modification of Annex 2 of the Agreement has resulted in spotty progress reporting and has reduced the Commission's ability to track the restoration of beneficial uses. Some jurisdictions continue to make steady progress toward the goals of Annex 2.

The public often expresses its concern that information on RAP implementation progress is not readily available in a standardized, consolidated report. The present situation requires visiting several Internet web sites containing a disparate collection of information.

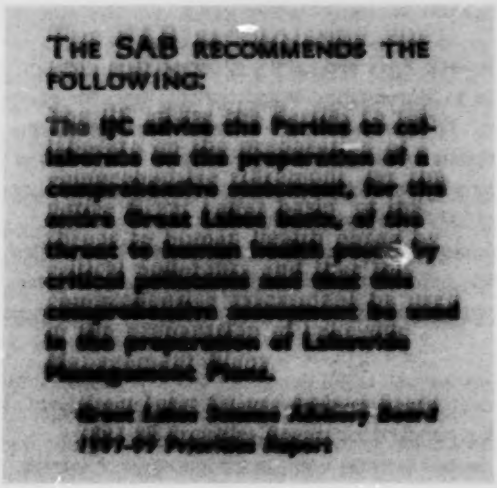
THE COMMISSION RECOMMENDS THAT:

Given the public's right to know the achievements in each AOC and what actions to expect in the future, the Parties should prepare a consolidated report on RAP progress that lists the accomplishments to date, funds expended, what remains to be done and the funds and timing required to finish the necessary work. Governments must clearly state what role they will be playing with each AOC and what resources they will be dedicating to restoring the impaired beneficial uses.

Lakewide Management Plans (LaMPs)

In 1999, the Parties emphasized accelerating the production of LaMP documents. The Parties adopted April 2000 for the publication of LaMP 2000, with updates proposed for every two years (BEC 1999). The Commission agrees with streamlining the LaMP process, provided the original intent of the plans as stated in the Agreement is maintained.

In this regard, the Great Lakes Science Advisory Board has expressed concern that LaMPs may contain outdated or incomplete information and thus convey an inaccurate or misleading message. Adaptive management techniques and iterative planning processes, as the Parties propose, are not substitutes for the data and information necessary to support decision-making to develop and implement a plan.



The Commission's review of previously submitted LaMPs raised the issue of human health. A Stage 1 LaMP must define the threat to human health or aquatic life and evaluate the available information on concentration, sources, and pathways of critical pollutants related to these threats. For example, the Commission's review of Lake Ontario's Stage 1 LaMP concludes that "shortcomings exist particularly in the area of defining the threat to human health and estimation of total loadings of critical pollutants" (IJC 1999c). This comment characterizes long-standing Commission concerns about LaMP development and the inadequate integration of human health issues related to critical pollutants. The Commission concurs with the Science Advisory Board's recommendation for a comprehensive assessment, for the entire Great Lakes basin, of the threat to human health posed by critical pollutants. For example, this assessment should clearly identify the critical subpopulations exposed to persistent toxic substances through their consumption of contaminated Great Lakes fish.

2.2 The Four Agency Framework

The Letter of Commitment regarding the Four Agency Framework ("the Framework"), signed in April 1998, is an agreement of the following four agencies: the U.S. Environmental Protection Agency, Environment Canada, the Michigan Department of Environmental Quality, and the Ontario Ministry of Environment. The Framework facilitates cooperation through a binational program focussed on AOCs shared by Ontario and Michigan in the connecting channels of the St. Marys, Detroit and St. Clair rivers.

The major accomplishment by February 2000 has been the development of position papers on the four major components of the Framework: administration, binational delisting, public involvement and outreach, and progress reporting. The papers focus more on reporting and administrative processes than on cooperative priority setting and remedial action. Also, it is unclear from the papers what mechanisms will be used to coordinate Canadian and U.S. remedial efforts on the Detroit River. However, the Parties are reporting increased collaboration particularly with respect

to flow modelling. They are putting in place complementary structures on both sides of the Detroit River to assist coordination and facilitate teamwork.

The Framework emphasizes restoration and the delisting of AOCs. The position papers concentrate on "delisting criteria" or "benchmarks used to assess the progress toward restoration of use impairments" (Environment Canada, Michigan Department of Environmental Quality, Ontario Ministry of Environment, and U.S. Environmental Protection Agency 1998a). The Commission's understanding is that the term "delisting" is used when an area is no longer designated an Area of Concern because all the beneficial uses are restored. Although the Commission agrees that every opportunity should be taken to recognize milestones and to celebrate accomplishments it believes that the overall goal of restoring beneficial uses should always be paramount. Any confusion regarding the term "delisting" carries the risk that the emphasis will appear to be directed more to the removal of a label than to restoration. The use of the term "restoration criteria" might clarify the issue and avoid this problem.

The Parties have committed to producing reports on each RAP every two years. (Environment Canada, Michigan Department of Environmental Quality, Ontario Ministry of Environment, and U.S. Environmental Protection Agency 1998b) It has taken two years to draft the position papers. Devoting more resources to these AOCs will ensure that such biennial reports will not be developed at the expense of programs that address the salient issues in the Areas of Concern. The Parties have recently stated that additional resources have been provided to implement the RAPs. The Commission encourages the Parties to issue the Detroit River and St. Clair River reports simultaneously to aid in coordinating the restoration of the connecting channels from Lake Huron to Lake Erie.

Another component of the Framework is public involvement and outreach activities. In the status assessment of the St. Marys AOC and the Detroit River AOC, the Commission concluded that inadequate consultation with citizens is an obstacle to progress in these two areas. (IJC 1997; IJC 1998) The Parties' commitment to provide financial and in-kind support for a set of core binational public involvement activities may go a long way toward overcoming some of the problems of public involvement that historically have troubled these AOCs.

Lake St. Clair

Two of the Areas of Concern under the Four Agency Framework are located to the north and to the west of Lake St. Clair – the St. Clair River AOC and the Detroit River AOC. This region comprises the full length of the corridor between Lake Huron and Lake Erie.

In its Ninth Biennial Report, the Commission recommended that the Parties review the current environmental status and programs in place to address environmental issues in Lake St. Clair in order to consider its designation as an Area of Concern. Both Governments responded that an AOC designation was not warranted and that "the AOC program would not be the most efficient program to address these issues" (U.S. Department of State and U.S. Environmental Protection Agency, Great Lakes National Program Office August 1999; Environment Canada 1999) .

At the Lake St. Clair: Its Current State and Future Prospects conference held from November 30 through December 1, 1999, participants concluded that remediation requires a coordinated, binational approach. The Commission is pleased to note that the Parties have recently agreed to include Lake St. Clair in the Four Agency Agreement in recognition of the interrelationship between the lake and the nearby AOCs. They have agreed "to address the environmental issues regarding Lake St. Clair in context of the St. Clair River/Detroit River Corridor, rather than as three discrete water bodies, when appropriate" (Environment Canada, Michigan Department of Environmental Quality, Ontario Ministry of Environment, and U.S. Environmental Protection Agency). The four agencies have already started to assess monitoring activities and identify existing data gaps as first steps in the establishment of a comprehensive monitoring approach to the corridor. Similarly, the Parties are examining research and modelling practices to help assure coordination of efforts in the corridor. The Commission commends the Parties for taking these steps and looks forward to future progress reports on these binational areas.

THE COMMISSION IS PLEASED TO NOTE THAT THE PARTIES HAVE RECENTLY AGREED TO INCLUDE LAKE ST. CLAIR IN THE FOUR AGENCY AGREEMENT . . .

2.3 Lake Superior: Zero Discharge Demonstration Program

In 1990 the Parties designated Lake Superior a zero discharge demonstration zone where no point source discharge of any persistent, bioaccumulative toxic substance would be permitted. The demonstration program was based upon the Agreement concepts of virtual elimination and zero discharge. The original thinking was that the program would be small enough to be completed in about five years, big enough to be a role model for the other Great Lakes, and a symbol of hope. There are only 41 major dischargers to Lake Superior, and it was

assumed that it would be easy to report on the quantities discharged. The discharge data should have been used to report current loadings and track trends in quantities discharged, as measures toward achieving the goal of virtual elimination. The Parties agreed to use the Lake Superior LaMP report to document progress on the Demonstration Program (Superior Work Group 1995; Lake Superior Binational Program 1999)

While the LaMP states that it is reporting on the program, it does not detail the successes of the program, nor does it provide the information necessary to assess the program's progress and effectiveness. In their 1999 Stage 2 Report on Load Reduction Targets for Critical Pollutants, the Parties acknowledge that the necessary information is not available to quantify the point source loadings into Lake Superior, even for the 41 major dischargers. The absence of the necessary baseline information makes it impossible to assess progress in meeting the zero discharge goal. (Lake Superior Binational Program 1999)

A notable accomplishment occurred when the pulp and paper industry changed its process for pulp bleaching by substituting chlorine dioxide for elemental chlorine. This substitution virtually eliminated the production of dioxins from pulp and paper mills.

Significant contaminant reductions have also followed plant closures. For example, two mine closures in the Lake Superior basin resulted in the elimination of their discharges of mercury and dioxins. The iron sintering plant in Wawa, Ontario, annually released 600 kg of mercury and 21.8 g of dioxins and furans prior to the plant's closing in June 1998. Similarly, the Copper Range smelter in White Pine, Michigan, annually released 550 kg of mercury before its closure in 1995. Although these emissions are significant, there are no estimates available that show the percentage contribution from these sources to the open lake waters.

The Zero Discharge Demonstration Program has confirmed the effectiveness of pollution prevention. For example, switching to batteries manufactured without mercury resulted in reduced amounts of mercury going into waste disposal. Waste pesticide collections in the basin yielded considerable amounts of banned pesticides, including dichlorodiphenyltrichloroethane (DDT), chlordane, and toxaphene for proper treatment and disposal. The Canadian PCB inventory recorded the destruction of large amounts of materials of high- and low-level PCBs between 1990 and 1997.

The Zero Discharge Demonstration Program exemplifies the difficulty of reconciling collecting data and compiling it into information for informed decision-making, versus the desire for immediate action. A further challenge arises from the different reporting schemes among the various jurisdictions, and particularly between

the two countries. The reporting requirements for the demonstration program would be enhanced by developing an institutional mechanism for ensuring that compatible data are collected and reported.

The initial challenge of zero discharge still provides a useful focus for assessing and controlling sources of critical pollutants from the 41 major point source discharges on the lake. (Lake Superior Binational Program 1999) However, the need to develop a comprehensive inventory on a multimedia basis, taking into account loadings from both inside and outside the Lake Superior basin, is clearly evident and remains unmet. Of particular note is the lack of information on the airborne pollution load, known to be significant, that is entering Lake Superior.

CHAPTER 3
PERSISTENT TOXIC SUBSTANCES

The problems of persistent toxic substances (PTS) dominate three annexes of the Agreement: Annex 12 (Persistent Toxic Substances), Annex 14 (Contaminated Sediment), and Annex 15 (Airborne Toxic Substances). The primary response of the Parties to persistent toxic substances is the Great Lakes Binational Toxics Strategy, which is discussed in Section 3.4.

3.1 Annex 12 - Persistent Toxic Substances

Annex 12 addresses definitions, general principles, programs, monitoring, early warning system, human health, research, and reporting. This annex embraces the philosophy of zero discharge and the goal of virtual elimination, and the Parties have achieved considerable success in controlling direct, point source discharges of toxic chemicals to the lakes. The Commission finds, however, that there are two remaining significant challenges to the virtual elimination of persistent toxic substances. The first is the historic burden of toxic chemicals in contaminated sediment; the second is the ongoing problem of airborne pollutants. The Parties' Great Lakes Binational Toxics Strategy does not adequately address either of these two remaining challenges.

The Commission's assessment of progress under Annex 12 examines the threat to human health, the early warning system, new and previously unidentified chemicals, chemical mixtures, and the general principles of the annex.

THREAT TO HUMAN HEALTH

The Parties have made progress in identifying the problems related to persistent toxic substances, most of which have human health implications. This work includes an increased understanding of the neurological, developmental, and transgenerational effects of some persistent toxic substances.

One of the main ways humans are exposed to persistent toxic substances in the Great Lakes basin is through consuming Great Lakes fish. Existing evidence demonstrates that the consumption of contaminated Great Lakes fish prior to and during pregnancy is associated with decreased birth weight and deficits in cognitive function in infants and children. Great Lakes fish contain many neurotoxins, including PCBs and methyl mercury, which can also produce interactive effects. These substances accumulate in the tissues of women and are transferred to the fetus during pregnancy and to infants during breast-feeding. Developing fetuses and nursing infants receive higher doses of toxic substances than at any other time in their lives. The subpopulations at greatest risk include First Nation and tribe members, sport fish anglers, and certain population groups who eat large quantities of Great Lakes fish. These facts raise the policy question of how best to protect human health, particularly for the more vulnerable sectors of the Great Lakes community.

A widely used governmental mechanism for addressing this policy question is the issuance of fish consumption advisories based on the current state of knowledge. The Great Lakes states have made significant advances in harmonizing their fish consumption advisories, taking into account the variation in concentrations of substances in different-sized fish of various species caught at different locations. Ontario advisories are based upon different sampling protocols from those used by the states and therefore sometimes provide different advice to consumers. The states of Ohio and Indiana both advise expectant and nursing mothers and children that "it is best to prevent exposure to fish contaminants in the first place" (Indiana State Department of Health and; Ohio Department of Health 2000). Fish consumption advisories assess risk and are not a guarantee of safety; and, there is always a danger that the advisory does not reflect the latest research. Over the past thirty years, fish advisories have generally become more restrictive as knowledge increased and more sensitive endpoints were reported from human health research.

"I'm concerned about a new strategy of lowering toxics body burdens by warning people 'repeatedly and emphatically' the fish are poisoned. . . Fish and wildlife will not be protected under this strategy."

Mary Sinclair
National Sierra Club

The Commission has some very serious concerns about the injury to human health from exposures to contaminants in Great Lakes fish. The Commission is most interested in how the Parties can reduce exposures of susceptible subpopulations until ongoing programs achieve acceptable concentrations of persistent toxic substances in fish tissue. The Commission commends the states of Ohio and Indiana for adopting a precautionary approach in recognizing the particular dangers of these chemicals to the development of embryos, fetuses, infants, and

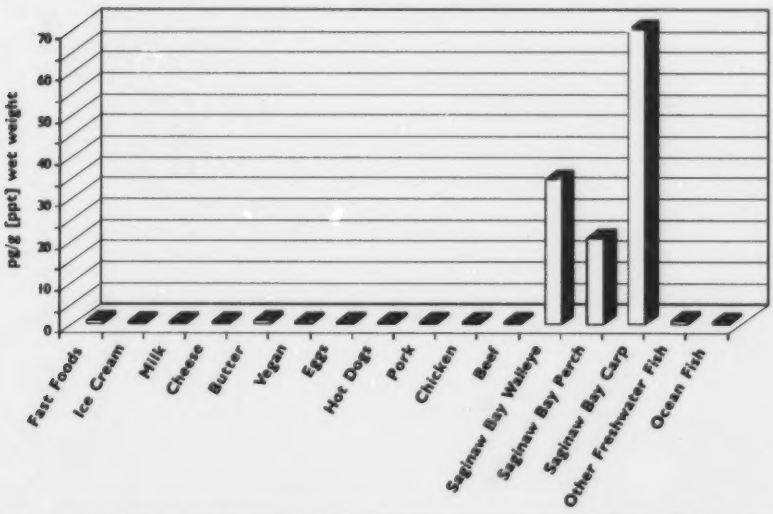
children. The Commission sees the need for a straightforward statement consistent with the recommendations of Ohio and Indiana that, for women of childbearing age and for children, it is best to prevent exposure to fish contaminants in the first place. The Commission is also concerned that advisories are not effectively distributed to women.

In the Commission's view, fish consumption advisories can only be an interim solution. They have been shown to have limited effectiveness among anglers, and, for First Nations and tribes, fishing is an integral component of culture and treaty rights. The long-term solution is clearly the restoration of the chemical integrity of the Great Lakes ecosystem to minimize exposure and subsequent bioaccumulation of persistent toxic substances in the tissue of fish. The Commission is asking its advisors to give further consideration to this matter over the next two years.

Figure 1 shows the dioxin-like activity of fish from Saginaw Bay compared to other foods. Appendix B illustrates the body of scientific knowledge to support a policy initiative in this area. The studies encompass the extent of human exposure to persistent toxic substances through consumption of fish and the subsequent effects of the substances.

Figure 1

Dioxin-Like Activity in Great Lakes Fish from Saginaw Bay Relative to Other Foods Sampled at Supermarkets throughout the U.S.



Adapted from Schecter et al. 1997; Schecter and Li, 1997; Giesy et al. 1997

THE COMMISSION RECOMMENDS THAT:

Governments should require that:

(i) sport fish consumption advisories state plainly that eating Great Lakes sport fish may lead to birth anomalies and other serious health problems for children and women of child-bearing age. These advisories should be addressed and distributed directly to women, in addition to their general distribution,

(ii) consumption advisories clearly identify fish to be totally avoided in light of the precautionary approach, and preparation methods for any that may be consumed, and

(iii) consumption advisories are supported by culturally appropriate community education programs directed to those who are likely to consume these fish.

Early Warning System

Another concern about Annex 12 relates to the reliability of models used to predict the ecosystem consequences of various loading rates of different persistent toxic substances. Computer simulations to identify the sources of these substances and their dispersal, fate, and distribution have advanced in the last few years.

In addition to simply estimating concentrations of chemical residues, the newer models incorporate monitoring data and consider indicators such as those based on fish, plants and nutrients. The modeling has been based on the physical and chemical properties of the molecules but requires monitoring data to confirm the predictions regarding the environmental fate and distribution of these substances. Furthermore, data deficiencies in discharge and emissions inventories, and inadequate information on chemical processes, increase the predictive uncertainty of the models. Models have proved adequate for planning research and monitoring, and have helped to elucidate source-receptor relationships to estimate the loading rates. Perhaps most important, the models point to the origin of loadings and indicate what actions need to be taken.

There is also very limited information indicating how much of a pollutant comes from a particular pathway and the relative importance of different sources to the loading contributions from a specific pathway. For example, there are limited measurements of dioxin in the Great Lakes atmosphere, and the air emissions inventories in both the United States and Canada are imperfect. As a result, scientists are unable to model atmospheric deposition of dioxin accurately. Dioxin is a sentinel toxic chemical for monitoring because it is detectable in trace quantities. Furthermore, an understanding of the relative importance of local, regional, national, continental, and global sources of certain persistent toxic substances is

needed to make scientifically supportable policy decisions, particularly in planning and implementing remedial measures. There is a clear need for the Governments to increase their efforts to obtain this information. Without this information, it is unlikely that Agreement goals to reduce the loadings of persistent toxic substances can be effectively achieved by the Parties.

New Chemicals and Previously Unidentified Chemicals

Another aspect of an early warning system is the ability to identify chemicals new to commerce and previously unidentified chemicals that may cause future environmental problems. For example, although scientists can chemically extract chlorinated hydrocarbon residue from the tissue of Great Lakes fish and birds, they can only identify about 30 percent of the material they find. Several halogenated compounds as well as antibiotic and other pharmaceutical residues in Great Lakes samples remain unidentified. The presence of brominated diphenyl ethers, chlorinated paraffins and naphthalenes, and PCB metabolites in the tissue of a variety of species, ranging from snapping turtles and herring gulls to polar bears and humans, remains a mystery. Retrospective analysis of tissue samples from Great Lakes species deposited in specimen banks since the early 1970s may help to ascertain the source of these chemicals.

HUMAN AND OTHER BIOTIC COMMUNITIES ARE MOST OFTEN EXPOSED TO A "CHEMICAL SOUP" OR MIXTURE; ONLY VERY RARELY ARE THEY EXPOSED TO A SINGLE CHEMICAL.

Chemical Mixtures

The question of chemical mixtures is also important. Human and other biotic communities are most often exposed to a "chemical soup" or mixture; only very rarely are they exposed to a single chemical. Many of these chemicals interact with each other externally in the environment or internally once inside the organism. How mixtures of chemicals affect exposed biota remains relatively unknown. Some chemicals behave either synergistically or antagonistically. In the absence of information on a specific mixture or combination, many regulatory agencies use a procedure first suggested by the U.S. National Academy of Sciences (1974) in which effects are assumed to be additive. This "default position" has withstood the test of time (over 25 years) and existing evidence often supports this position. However, this observation offers little comfort because of the multiplicity of combinations and permutations among chemicals in the environment.

"With a number of organic pollutants which cause effects such as immunosuppression and hormone disruption, research is showing that mixtures can have an additive or synergistic effect. It appears that the fetus is most at risk to the effects of these types of pollutant. Under these circumstances classical risk assessment ceases to be of use and it becomes difficult or impossible to predict effects. Society does not really possess the intellectual, regulatory or legal instruments to approach such problems currently. However the mantra of "There is no evidence" - to justify the continuation of the current bulk global production of persistent bioaccumulative toxic substances - simply will not do. . . . Future generations will not thank us for failing to take a precautionary approach during our temporary stewardship of the environment which they will have to inherit"

Dr. Vyvyan Howard
Synergistic Effects of Chemical Mixtures -
Can We Rely on Traditional Toxicology
The Ecologist, Vol. 27, No.5 (1997)

The Parties should undertake research on the theoretical aspects of the chemical and physical properties of known substances that could produce synergistic or antagonistic effects when in mixtures. The Parties have used dioxin "equivalents" to evaluate mixtures of PCB isomers, dioxin, and furans, and the technique offers possibilities for evaluating the risk and effects of other chemical mixtures. The effects of mixtures is an area of research that the Commission believes will offer considerable help to the Parties as they work on identifying persistent toxic substances and their effects.

General Principles

Annex 12 refers to "General Principles." The first encompasses the well-known Agreement concepts of virtual elimination and zero discharge. The second principle, rehabilitation, acknowledges that virtual elimination and zero discharge are necessary, but not sufficient, to achieve Agreement goals. Rehabilitation recognizes the importance of addressing persistent toxic substances that are already present in the ecosystem and are causing adverse effects. Rehabilitation is generally achieved through remediation under the RAPs and LaMPs and cannot be addressed by the Parties' emphasis on pollution prevention policies and programs. In its Seventh Biennial Report (1994), the Commission endorsed the work of its Virtual Elimination Task Force in the consideration of persistent toxic substances under Annex 12. At that time, the Commission noted that zero discharge means absolutely no release of chemicals, not merely "below the level of detection" of

available analytical instrumentation. The Task Force also recognized the need to apply certain concepts, notably reverse onus, and a precautionary approach. These two ideas mean respectively that "a chemical is presumed harmful unless proven otherwise" and that "when there is a serious risk of environmental damage, even though scientific certainty has not been established, it is prudent to take (cost-effective) measures to reduce or eliminate the risk" (IJC 1993).

The Commission welcomes the addition of the concept of virtual elimination to the Canadian legislative framework. Canada has led in this regard by being one of the first countries in the world to incorporate the concept into federal policy and now into the revised Canadian Environmental Protection Act (CEPA). CEPA's effectiveness will depend, however, on how it is implemented and on the accompanying regulations which, for example, will need to define "persistence." The Commission prefers adoption of a definition consistent with the Agreement. Given the Commission's interpretation of the term "zero discharge" as literally zero discharge, the Commission will take a special interest in how Environment Canada sets the Levels of Quantification in the CEPA regulations, in conjunction with provisions in other sections of CEPA that can be used to ban the manufacture, import, export, and use of designated persistent toxic substances.

3.2 Annex 14 - Contaminated Sediment

The persistent toxic substances found in contaminated sediment are the dominant issue in the Areas of Concern. Annex 14 requires that the information obtained through research and studies under this annex guide the development of RAPs and LaMPs.

Sediment remediation is a large-scale, high-cost problem throughout the Great Lakes basin. Beginning with the 1975 final report of the IJC International Working Group on the Abatement and Control of Pollution from Dredging Activities, the Commission has sponsored numerous technical workshops and received extensive advice from expert committees. In 1999, the Great Lakes Water Quality Board's Sediment Priority Action Committee (SedPAC) identified obstacles to sediment remediation and developed data interpretation tools to support sediment management decisions. In addition, SedPAC offered several recommendations to improve ecological assessment and monitoring programs to enhance recovery forecasting and benefit measurement.

The policy and program requirements needed to support a binational program for the management of contaminated sediment are clearly articulated under Annex 14.

They include comprehensive problem definition, development of common assessment methodologies, review of contaminated sediment classification practices, establishment of compatible criteria for sediment quality classification, development of biological indicators, development of a standard approach and management procedures, cooperative technology assessment, design and implementation of demonstration projects at selected Areas of Concern, and establishment of measures for long-term disposal and beneficial reuse of contaminated sediment.

The Commission notes that the Parties have accomplished some of the elements required in Annex 14. For example, the U.S. and Canada adopted similar classification practices and compatible criteria for remediating contaminated sediment. However, the emphasis on site-specific characteristics in each AOC has resulted in wide variations in remediation practices. This was evident when the Commission compared remediation projects in the Black River in the United States and Hamilton Harbour in Canada. There were significant differences in the final levels of polycyclic aromatic hydrocarbons (PAHs) in these two AOCs. In the Black River, sediment removal resulted in final PAH concentrations in the remaining sediment ranging between 6 and 37 mg/kg. As a result, Black River fish show significantly fewer tumors than previously noted. (Ohio Environmental Protection Agency 1999) In contrast, the Randle Reef Project in Hamilton Harbour proposes a final PAH concentration of 700 mg/kg. This level is well above the objectives achieved for the Black River and the lowest effect levels based on Canadian guidelines.

Therefore, it is recommended:

"Much greater emphasis be placed on post-project monitoring of the effectiveness of sediment remediation (i.e. assessment of effectiveness relative to restoration of uses with appropriate quality assurance and quality control)."

Great Lakes Water Quality Board 1997-99 Priorities Report, IJC 1999d

That the PAH level allowed for the Randle Reef project is considerably higher than the upper limit of the range for the Black River is inconsistent from both a scientific and policy perspective. PAHs are established carcinogens and, as demonstrated by remediation efforts in the Black River, minimizing their allowable residue in biota and environmental media advances the goal of restoration.

The situation of the Hamilton Harbour AOC is more complex than that of the Black River because, in addition to PAHs, fish consumption advisories are in place in Hamilton Harbour for PCBs, mercury, and mirex. There also are documented sources of dioxin in air emissions from the Stelco sintering plant. The Commission is concerned that the proposal to incinerate pretreated contaminated

sediments in the same sintering plant could lead to the production and release of more dioxins. These conditions provide a good example of the problem of chemical mixtures. A more holistic analysis, utilizing the precautionary approach applied to human health concerns for multiple bioaccumulative chemicals, would assist in this case. As recommended by the Great Lakes Water Quality Board, this situation would also benefit from close post-project monitoring.

Natural Recovery

Although SedPAC noted the need to consider natural recovery as a viable cleanup option, the issue is potentially contentious. Natural recovery can take as few as five years, for example, to eliminate kepone in the James River, Virginia, or well over 10,000 years to eliminate substances such as radioactive waste. This range of recovery time warns of the need for a careful analysis of the approaches being considered. It would also be important for an effective public outreach effort to determine that a cleanup that could take several generations would be acceptable to a well-informed public.

"How clean is clean enough? And on what timetable?"

Rebecca Katers
Clean Water Action Council
Green Bay, WI

Current Status

The Commission has summarized progress related to sediment remediation in Areas of Concern. Clearly, the problem remains significant. Less than 2.4 percent of known contaminated sediment by volume in U.S. AOCs is remediated while, in Canada, the amount is only 0.2 percent (See Figures 2 and 3). The Parties have adopted some elements of Annex 14 (Contaminated Sediment) and are cooperating with respect to technology programs. However, they have not developed standard approaches, agreed management procedures, and long-term measures related to disposal and sediment reuse as required by the Agreement. The Commission concludes that the initiatives related to both RAPs (Annex 2) and contaminated sediment (Annex 14) require a long-term, binational effort and program that reflects the magnitude of the contaminated sediment challenge.

THE COMMISSION RECOMMENDS THAT:

Governments should immediately develop a comprehensive, binational program to address the full scope of the contaminated sediment problem over the long term, setting appropriate priorities and defining the resources required for completion. As part of this comprehensive program, governments should ensure that:

(i) programs and cost estimates are in place and made public for fully addressing contaminated sediments in Areas of Concern,

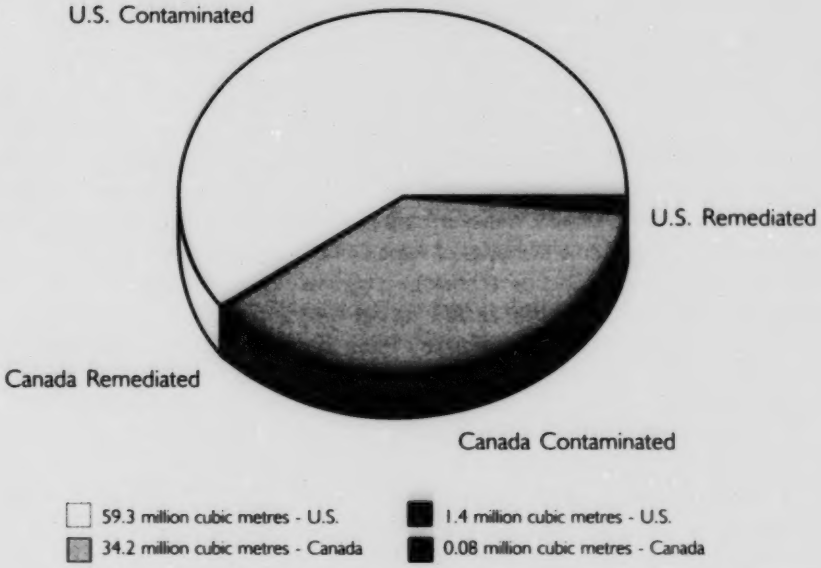
(ii) timetables for fully implementing those programs are established and made public,

(iii) resources are provided to fully implement the programs in accordance with the established timetables, and

(iv) progress reports are issued at least biennially.

Figure 2

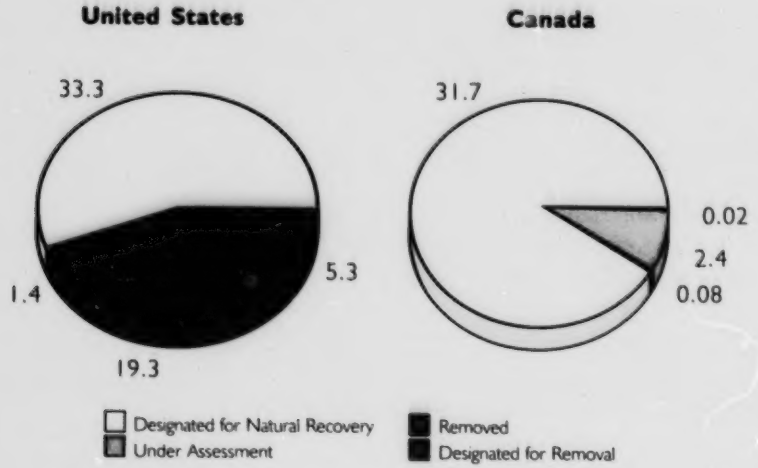
Contaminated Sediment in the Great Lakes Areas of Concern


U.S. Contaminated
U.S. Remediated
Canada Remediated
Canada Contaminated
59.3 million cubic metres - U.S.
34.2 million cubic metres - Canada
1.4 million cubic metres - U.S.
0.08 million cubic metres - Canada

Source: Compiled by Commission staff, based on the best available estimates.

Figure 3

Management Status of Contaminated Sediment in Areas of Concern



All quantities are in million cubic metres

Source: Compiled by Commission staff, based on the best available estimates.

3.3 Annex 15 - Airborne Toxic Substances

Annex 15 recognizes that the atmosphere is a major pathway by which persistent toxic substances reach the Great Lakes. This annex includes provisions for research, monitoring, and modeling and establishes the components of the Integrated Atmospheric Deposition Network (IADN).

It is essential to place the atmospheric contribution to the pollution of the Great Lakes in the context of the total pollutant sources and the pathways that bring such pollutants to the lakes. Such determinations are needed to partially fulfill commitments by the Governments under Annex 15 of the Agreement. In addition, the Great Lakes Binational Toxics Strategy makes commitments to determine and manage the numerous sources of these contaminants. These determinations would support the further analysis of exposure and risk of pollutants, the development of regulatory controls, and the ultimate redesign of industrial processes to reduce and prevent discharges and emissions.

Airborne pollutants deposited in the lakes originate from both local and distant sources. The pollutants enter the atmosphere from direct emissions (smokestacks, combustion, automobiles) or through volatilization and evaporation from terrestrial or aquatic surfaces. The atmosphere transports the pollutants as particles, aerosols, or gases and the pollutants can be deposited directly onto solid or aquatic surfaces (dry deposition), or washed out of the atmosphere by rain and snowfall (wet deposition). A few pollutants remain suspended in the atmosphere for such a long period of time that they become part of a "regional or global background" level of pollution.

The relative importance of air as a pathway depends on the nature and number of the other pollutant sources in a given location. Lake Superior has relatively few point sources and the largest surface area. Because the deposition of material from the atmosphere is directly proportional to the surface area, Lake Superior receives a large percentage of selected persistent toxic substances via air deposition.

Integrated Atmospheric Deposition Network

To determine the significance of the atmosphere in the distribution and behavior of toxic contaminants in the Great Lakes, the Parties, principally the U.S. Environmental Protection Agency and the Atmospheric Environment Service (Canada), created the Integrated Atmospheric Deposition Network (IADN). This network combined "master" and "satellite" stations, as recommended in the Commission's 1988 Plan for Assessing Atmospheric Deposition to the Great Lakes.

The operation of IADN is an excellent example of a binational program that generates both comparable and compatible monitoring data on both sides of the international boundary. Locations were chosen for the master and satellite stations to allow quantification of the level of regional background for selected persistent toxic substances. One of those pollutants, mercury, in its elemental form volatilizes easily. Many of the organic compounds of mercury share this volatility characteristic. Thus, mercury and its compounds are contaminants requiring a "regional background" assessment as a vital piece of information for setting control strategies and regulatory approaches. However, IADN does not currently include mercury among the measured pollutants. This situation reflects the historical limitation on resources because, until recently, mercury analysis of air samples was very expensive.

Similar cost considerations were also cited in the exclusion of dioxin from the IADN roster. More recent analytical methods for mercury and dioxin appear less costly and, given the ongoing efforts to model the transport of these two contaminants to the lakes, enhancement of the network by inclusion of mercury and dioxin in the program should again be considered.

Although IADN is a significant achievement, success in the surveillance and research aspects of Annex 15 has been limited over the last decade because important components, such as emissions inventories and research, have not been pursued to the extent that they would enable the Parties to meet their obligations under this annex.

THE OPERATION OF IADN IS AN EXCELLENT EXAMPLE OF A BINATIONAL PROGRAM THAT GENERATES BOTH COMPARABLE AND COMPATIBLE MONITORING DATA ON BOTH SIDES OF THE INTERNATIONAL BOUNDARY.

LINKING DISTANT SOURCES TO THE LAKES

To assist the Parties in the development of source-receptor and air trajectory modeling, the International Air Quality Advisory Board (IAQAB) of the Commission supported application of the NOAA HYSPLIT (Hybrid Single Particle LaGrangian Integrated Trajectory) model to quantify dioxin contamination from sources internal and external to the Great Lakes basin.

HYSPLIT is capable of viewing atmospheric deposition from two perspectives. Starting with a source of emissions, such as a coal-fired plant in the U.S. midwest, the model estimates what fraction of those emissions will arrive (be deposited) at a specific site, such as Lake Michigan. Alternatively, starting with a site such as Lake Michigan, the model could determine likely airborne sources of a given pollutant and the relative significance of each source.

HYSPLIT depends upon the availability of several supporting elements, including a good-quality emissions inventory, adequate simulation of the behavior of the pollutant in the atmosphere, and the availability of ambient measurements for calibration and verification. Despite the limited data on emission inventories and ambient measurements, as described in the 1997-99 Priorities and Progress under the Great Lakes Water Quality Agreement Report (IJC 1999d; Cohen, M. and Commoner, B. 1995), the model outputs have been found to be reasonable and realistic for dioxin. If the supporting elements are improved, HYSPLIT or similar models could be a useful mechanism to establish the amount and relative significance of long-range atmospheric transport to the total burden of airborne persistent toxic pollutants in the Great Lakes.

The Commission is confident that the tools exist or can be further developed to determine the contribution of local, regional, continental, and global sources to the atmospheric deposition of persistent toxic substances into the Great Lakes basin. Some of these tools include those identified earlier — HYSPLIT and IADN and their supporting elements, including emissions inventories, physical and chemical determinations, and other ambient measurements.

THE COMMISSION RECOMMENDS THAT

The Parties should take the following measures to deal with airborne pollutants:

(i) identify both in-basin and out-of-basin sources of atmospheric deposition of persistent toxic substances to the Great Lakes, quantify their contribution to the total burden of these substances to the lakes, and use this information to formulate and implement appropriate prevention and control measures; and

(ii) adopt a source-receptor computer model, improve emissions inventory information, and add dioxin and mercury to the Integrated Atmospheric Deposition Network to improve the data bases for these two substances.

3.4 The Great Lakes Binational Toxics Strategy

The Great Lakes Binational Toxics Strategy ("the Strategy"), signed on April 7, 1997, established a collaborative process between the Parties and stakeholders to address the goal of virtual elimination of targeted persistent toxic substances in the Great Lakes basin. The strategy uses three processes to facilitate consultation: substance-specific workgroups, stakeholder forums, and an integration workgroup. An underlying tenet of the Strategy is that the Governments cannot achieve the goal of virtual elimination by their actions alone. Thus, it "challenges all sectors of society

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The Substance Specific Workgroups undertake a four step analytical process:

Step 1 - **Information gathering**

Step 2 - **Analyze current regulations, initiatives, and programs**

Step 3 - **Identify cost effective options to achieve further reductions**

Step 4 - **Implement actions to work toward the goal of virtual elimination of the targeted substances.**

to participate and cooperate to ensure success" (U.S. Environmental Protection Agency and Environment Canada 1997).

The work of the substance-specific workgroups comprises the core activity under the Strategy. Meetings with stakeholders are held twice a year to encourage an open participatory process of consultation on Strategy implementation. The Integration Workgroup functions to provide oversight and coordination and to discuss other issues that may fall outside the scope of the substance-specific workgroups.

The Mercury Workgroup

The Mercury Workgroup, one of the seven substance-specific workgroups, has effectively mobilized the activities of a broad spectrum of stakeholders. The group aims to reduce and eliminate mercury use and disposal in the environment. This includes eliminating mercury from such diverse sources and sectors as sewage treatment plants, electric utilities, schools, the metals industry, health care, mining, and industrial production processes. It also involves removal of mercury from a variety of commercial products and household uses, such as medical thermometers, thermostats, lamps, appliances, automobiles, and switches. The group accomplishes this work through initiatives involving joint activities with, for example, the Commission for Environmental Cooperation, the Chlorine Institute, and the steel industry. Community outreach and education activities are also undertaken by promoting better disposal methods that emphasize life-cycle analysis of mercury-containing products.

The control of mercury, one of the persistent toxic pollutants, represents one of the success stories of the Strategy. Significant reductions have been reported. The workgroup has established a mercury Internet web site, which provides information on sources and regulations by topic and sector. In addition to the impact of its direct initiatives, the workgroup has helped in expanding knowledge about the chemical, environmental, and human health effects of this material, and about its sources and environmental behavior. The workgroup has also benefitted from the work of a well-networked group of researchers from Labrador to Florida on the Atlantic coast and from Alaska to southern California on the Pacific coast. In addition, the electric power industry has an established network of researchers; fossil fuel, mainly in coal-fired power plants, is one of the major sources of mercury emissions to the environment.

Progress in environmental control of mercury has occurred despite the fact that IADN does not include mercury in its program. If IADN included mercury, the workgroup could estimate loadings of mercury to the Great Lakes, thereby assessing the ecosystem effects of its reduction efforts.

Other Workgroup Progress

Workgroups created by the Strategy are also addressing the other eleven designated persistent toxic substances. After three years, however, no workgroup has entirely completed the four-step process. For example, the PCB Workgroup is currently focusing on steps 3 and 4, but has only documented actions for the reduction of PCB inventories currently in use or in storage. This initiative does not address PCBs in sediments or the deposition of PCBs from long-range sources via the atmosphere. Although PCBs in use and in storage may constitute a potential long-term threat, PCBs circulating in biota cause the greatest immediate harm to Great Lakes fish, wildlife and humans.

Similarly, the Dioxin/Furan Workgroup has been unable to quantify sources of these substances to the Great Lakes as a basis to determine priorities for action. Major source reductions of dioxin are estimated based on new national standards in the United States and Canada primarily related to incineration. Another major source reduction in Canada was recently achieved by process changes in the pulp and paper industry that avoid the use of elemental chlorine in bleaching. Without quantified estimates of the contributions of all sources to the Great Lakes, however, strategic and cost-effective reduction opportunities cannot be identified with certainty. As an illustration, pollution prevention initiatives to restrict open burning and replace older technology woodstoves may represent greater or fewer opportunities for reductions than programs targeting other sources. Given that the state of knowledge and available data for PCBs and dioxins are somewhat advanced, the Commission encourages the Governments to adopt a more strategic approach with these substances to ensure that adequate data, information, and research are made available to the workgroups to support them in moving forward decisively to steps 3 and 4 in the process.

Deficiencies of the Strategy

The Commission recognizes the significant yet disparate effort being sustained in the Strategy, and it is concerned that the effectiveness of the Parties' efforts are being compromised by inadequate data and information on sources. The Strategy places emphasis on the substance-specific workgroups to address reduction opportunities separately for each substance, which can limit the ability of the Integration

"Right now the Canadian and U.S. governments - the agencies - are very reluctant to actually set a real schedule for virtual elimination."

Andy Buchsbaum
Great Lakes Office
National Wildlife Federation

Workgroup to adopt an overall strategic approach. The Commission is sensitive to the fact that any and all reductions of persistent toxic substances are worth pursuing. However, setting priorities for the virtual elimination of the targeted substances may be the most effective manner to reduce significant or important sources of the pollutant. This issue can be addressed with improved data, information, and reporting with respect to steps 1 and 2 of the Strategy's four-step analytical process. Greater emphasis on sources and emissions could lead to a more strategic approach and would make major inroads into producing effective overall emission inventories. The effectiveness of steps 3 and 4 of the process for all the substances would also be improved with greater oversight of the Integration Workgroup, using the stakeholder forums to assist with policy implementation.

THE COMMISSION IS SENSITIVE TO THE FACT THAT ANY AND ALL REDUCTIONS OF PERSISTENT TOXIC SUBSTANCES ARE WORTH PURSUING. HOWEVER, SETTING PRIORITIES FOR THE VIRTUAL ELIMINATION OF THE TARGETED SUBSTANCES MAY BE THE MOST EFFECTIVE MANNER TO REDUCE SIGNIFICANT OR IMPORTANT SOURCES OF THE POLLUTANT.

In an attempt to advance the state of knowledge with respect to the sources and transport of persistent toxic substances to the Great Lakes, the Commission's IAQAB undertook an analysis of dioxin deposition in the Great Lakes. The Board recognized the need for a comprehensive, binational emissions inventory of in-basin and out-of-basin point sources and source regions of this contaminant. By bringing together experts from federal, provincial, and state governments, this inventory and associated binational digital maps were produced, which then allowed the modeling of dioxin deposition to the lakes, and the accompanying identification of significant sources and source regions.

The IAQAB also assembled a U.S. county emissions data base for several of the persistent toxic substances of concern as well as a preliminary compilation of related control programs and outcomes for both the United States and Canada. The IAQAB has demonstrated the feasibility of this type of analysis and the Commission recommends that the Governments utilize a similar technique to advance further their knowledge and understanding of the air pathway as it applies to the Strategy.

This work of the IAQAB has demonstrated that the resources and technology exist within the Governments to rigorously pursue the goal of virtual elimination under the Strategy in a truly binational manner. The Commission believes that a reliance on actions to reduce persistent toxic substances discharges through pollution prevention, while necessary, is not sufficient to enable the Parties to fulfill their obligations under the Agreement.

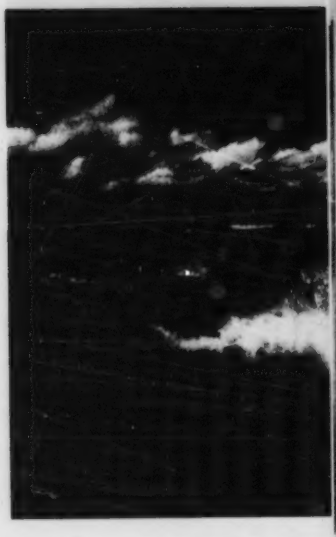
THE COMMISSION RECOMMENDS THAT:

The Parties should strengthen the Great Lakes Binational Toxics Strategy by fully addressing all sources of persistent toxic substances, such as atmospheric transport and deposition and *in situ* contaminants in sediments. In order to include the air pathway the Parties should:

i) **establish an inventory of baseline air emissions for toxics for all of the United States and Canada.**

ii) **undertake a complete analysis of emission reduction scenarios for key source regions and determine their effectiveness in reducing contamination of the Great Lakes from the air.**

The Parties should ensure that the Strategy is truly both strategic and binational by strengthening the integration and priority setting component and establishing a full-time binational secretariat.



CHAPTER 4
LAND USE

4.1 Annex 13 - Pollution from Nonpoint Sources

Annex 13 further details the Parties' Article VI commitments to abate and reduce pollution from land use activities. The Parties are required to identify land-based activities contributing to water quality problems in RAPs and LaMPs, as established under Annex 2, and to develop and implement watershed plans. The annex also provides for protection of threatened wetland areas, monitoring and surveillance, demonstration projects, and biennial reporting.

AGRICULTURAL SECTOR

Considerable progress has been achieved in the agricultural sector. (Great Lakes Commission 1996) Recent reports related to Annex 13 document the Parties' efforts to reduce nonpoint source pollution from agricultural sources, principally sediment, nutrients, and pesticides. A variety of policy initiatives now encourage the widespread adoption of conservation tillage, buffer strips, integrated pest management, and environmental farm plans. Progress on these issues continues to be made through ongoing extension advice and programs. Where atmospheric or groundwater pathways are critical, however, water quality can be adversely affected by nutrient and pesticide loadings caused by specific farm practices. There is also growing concern about the disposal of animal wastes generated by large-scale hog and beef production.

URBAN GROWTH

Scientific understanding of pollution from land uses has changed considerably since the landmark final report from the Commission's Pollution from Land Use Activities Reference Group (PLUARG) in 1978 [2]. PLUARG focused on the impact of agricultural and

2 The IJC's Pollution from Land Use Activities Reference Group (PLUARG) was established under the 1972 Agreement to determine the cause and extent of pollution originating from land use activities, and to recommend appropriate actions. PLUARG reported its findings to the Commission in 1978, and the IJC forwarded a set of recommendations to the Parties in 1980. PLUARG confirmed two major pollution problems in the basin: eutrophication, due to elevated nutrient inputs, particularly in Lake Erie and Lake Ontario; and increasing contamination by toxic substances.

forestry practices. More recent studies have examined the effects of urban growth. In 1996, the State of the Lakes Ecosystem Conference (SOLEC) addressed these issues in the context of its theme, The Year of the Nearshore, and documented extensive threats from nonpoint source pollution affecting lakes Michigan, Erie, and Ontario. SOLEC concluded that a major source of stress to the Great Lakes ecosystem is growth and development, notably urban sprawl. SOLEC also concluded that changing land use in the Great Lakes basin, particularly the trend over the past 20 years toward greater urbanization, is accelerating and is producing profound negative effects. The SOLEC conclusions go well beyond the impacts initially assessed by PLUARG.

In 1998, the 20th anniversary of the final PLUARG report provided an opportunity to reassess Agreement progress and related scientific thinking about land-based pollution control. (Great Lakes Science Advisory Board 2000) This reassessment affirmed SOLEC '96 findings. Extensive urbanization in the basin creates more impervious surfaces, thus increasing runoff and impairing water quality in urban watersheds. The extent of such impervious surfaces is a key variable in predicting pollutant loads and flooding. Continued urban growth over the next two decades will result in increased pollutant loads to the lakes from urban nonpoint sources unless action is taken now to manage it.

The major pollutants in urban waterways are nutrients, pathogens, sediment, industrial chemicals, and pesticides (Table 1). These pollutants are often released intermittently. The short-term surges can produce greater deleterious effects than continuous low levels of exposure. When surges happen, the ambient water

Table 1 Urban Pollutant Sources

Pollutant Category	Probable Sources
Nutrients	• **Atmospheric deposition and washout** • **Septic system effluent through groundwater or system overflows** • **Lawn fertilization**
Pathogens	• **Urban wildlife and domestic pets** • **Wastewater discharges**
Sediment	• **Channel erosion from increased storm water runoff due to impervious surfaces** • **Exposed soils at construction sites** • **Urban runoff (e.g. tire wear from city streets)**
Industrial Chemicals and Pesticides	• **Intermittent pulse exposures, often weather-related** • **Runoff and groundwater contamination from land-based sources, including waste disposal sites**

conditions exceed the established water quality criteria. The primary management tools for reducing urban nonpoint source pollutants are storm water best management practices that detain, retain, and treat pollutant-laden runoff.

The commitment to develop and implement watershed plans in Annex 13 implies a community-based planning process to determine which tools are the most feasible, effective, and acceptable in achieving reduction targets. Key tools related to planning, regulation, and education have been identified (Schueler 1998). Planning tools include reducing impervious surfaces, implementing better site design, and incorporating natural hydrologic features to enhance storm water management. In addition, best management practices, such as stream buffers to control runoff and erosion, are essential to protect stream integrity. Regulatory measures exist as well, including ordinance and bylaw protection of significant natural features, such as floodplains, as well as regulations to ensure adequate erosion and sediment control during subdivision development. Regulatory tools can also be used to address failing or inadequate septic systems that are potentially significant sources of pathogens and nutrients. Finally, education and increased public awareness encouraging informed decision-making complete the tool kit.

A Role for the Parties in Urban Watersheds

The impact of nonpoint source pollution at the watershed and regional levels is broad in scope, even though it is usually perceived as primarily a local problem requiring a local solution. Thus, there is an essential role for senior governments. The Parties need to ensure that policy, data, and information tools are available to manage and mitigate the effects of myriad development decisions in urban watersheds over the long term as well as the increasing residential development in more rural areas. Currently, there is no linkage between local development decisions and the provisions of Annex 13. The trend to transfer responsibilities and programs to local governments, and the growing economic and political importance of metropolitan areas throughout the basin, has made this linkage more difficult.

Currently, there is no linkage between local development decisions and the provisions of Annex 13.

There is a need for a framework or guidance policy that will enable all levels of government to work cooperatively to achieve Annex 13 goals. A guidance policy needs to be developed for urban land use planning throughout the basin in partnership with the Great Lakes states and provinces. The potential of new "sustainable cities" concepts and "smart growth" strategies for the protection of ecosystem integrity should be evaluated and incorporated as appropriate. This guidance policy should apply to all activities and projects on federal lands, and to all other

areas that involve federal spending related to urban development. All jurisdictions in the basin responsible for land use should incorporate the guidance policy into their land use planning policies and decision-making.

Wetland Preservation

Land use changes have also significantly altered ecosystem structure and function — for example, through drainage of aquatic and wetland systems. Understanding these impacts provides valuable insight into the effect of land use changes on the basin ecosystem. SOLEC '98 recognized the importance of identifying and protecting basin wetlands, building on the original concept of Biodiversity Investment Areas as introduced at SOLEC '96 (Holland and Reid 1996).

SOLEC activities with regard to Biodiversity Investment Areas are leading to the creation of a geographic information system (GIS)-based inventory, a standard system for classification, and the identification of some of the most ecologically important areas to target for conservation. This represents significant progress under the Agreement related to wetland preservation as well as to the development of a broader understanding of the impacts of land use changes and nonpoint source pollution in the basin. Governments must now take steps to preserve these areas and, where necessary, rehabilitate them. The identification of Biodiversity Investment Areas constitutes an essential preface to the development of a binational policy and strategy for wetlands protection. It provides a sound foundation based on a comprehensive data and information system and assessment. A similar approach to identify and quantify nonpoint sources of pollution from land use activities is urgently required.

THE COMMISSION RECOMMENDS THAT:

The Governments should provide for a binational study of the effects of changes in land use on Great Lakes water quality to determine the measures that should be taken to address these changes, including:

- **(i) the effects of urban and residential growth,**
- **(ii) the effectiveness of existing policies and programs in controlling pollution from land use in all sectors, and**
- **(iii) the identification of measures that should be taken by provincial and state governments, with appropriate assistance from the Parties, to prevent adverse effects.**

Governments should proceed with implementation of the SOLEC work on Biodiversity Investment Areas, emphasizing the preservation and rehabilitation of wetlands.

Chapter 5
Coast Guard Annexes

5.1 Annexes 4, 5, 6, 8 and 9

Annexes 4, 5, 6, 8 and 9, commonly referred to as the Coast Guard Annexes, relate primarily to toxic and pollutant threats from shipping activities. They are often cited as examples of how the two countries, even under resource constraints, can work together effectively. The Coast Guards prepare a joint report for the Commission every year (U.S. Coast Guard/Department of Fisheries & Oceans Canada/ Transport Canada Marine Safety 1999). One aspect of the Coast Guard Annexes is that the associated programs reside primarily in federal agencies. This has eased difficulties associated with the coordination and development of binational procedures and programs.

Emergency Response

The Commission continues to be encouraged by the extent of binational collaboration under the joint contingency planning requirements of Annex 9 of the Agreement. Annex I of the Canada - U.S. Joint Marine Contingency Plan, which is referred to as CANUSLAK, applies to the Great Lakes region. The Coast Guards stage joint practice exercises, which include the local tribes and First Nations as well as the state, provincial, and local governments. This plan was tested in a real spill on June 2, 1998, when the Canadian Coast Guard responded to a sewage and oil spill in the Detroit River. This event demonstrated the high degree of cooperation and coordination between the Canadian and U.S. Coast Guards.

Discharges from Vessels

Under Annex 4, the Parties are required to adopt regulations to prevent discharges of harmful quantities of oil and hazardous polluting substances from vessels. In Annex 8, there is a similar restriction on discharges from onshore and

offshore facilities. According to statistics presented in Coast Guard reports, the majority of oil spills in the Great Lakes are less than 10 gallons. The marine transport of oil and chemicals appears to be under tight management, with minimal impact on the integrity of the Great Lakes. Most spills over 500 gallons are from nonmarine sources, such as industrial plants and railroads.

The discharge of garbage is prohibited under Annex 5 while cargo residue is not mentioned. The current practice in both countries allows the discharge of cargo residues into designated areas of the Great Lakes. There is an apparent contradiction with the International Maritime Organization definition that includes cargo residue in a broad definition of garbage. However, in the Great Lakes the discharge of garbage is clearly prohibited. Annex 6(1)(d) requires the Parties to review practices and procedures regarding the prevention of pollution from the loading, unloading, or onboard transfer of cargo, but does not refer explicitly to cargo residue.

Annex 6 requires the Coast Guards and involved Canadian agencies to review pollution from shipping sources. The annex calls for consultation to exchange information, identify and prioritize problems needing study, coordinate studies, and report to the Commission. The close working relationship among these agencies has resulted in good coordination and consultation.

The Coast Guard reports state that vessel-related sources of contaminants such as sewage and small oil spills are not a threat, in the volumes being discharged, to the physical, chemical, or biological integrity of the waters of the Great Lakes.

5.2 Alien Invasive Species (AIS)

Coast Guard reports under Annex 6 outline studies that have been undertaken relating to the major issue of the discharge of ballast water from vessels. Annex 6(1)(b) requires the Parties to review "practices and procedures regarding wastewater and their deleterious effect on water quality, including, as required, studies to determine if live fish or invertebrates in ballast water discharges into the Great Lakes System constitute a threat to the System." Over the past decade, the primary focus of activities under this annex has been to prevent and control the introduction and interbasin spread of alien invasive species (AIS) from the discharge of ballast water. These species are also referred to as aquatic nuisance species (ANS). When these species are introduced into the Great Lakes waters, they can upset the balance of the natural ecosystem, threaten native species, and cost millions of dollars in control and management. Two well-known examples are zebra mussels and round goby.

"Despite progress in many areas, the Great Lakes Panel has recognized a particularly critical problem: a lack of interjurisdic-tional consistency in laws, regulations and policies directed at ANS prevention and control efforts. Preliminary research found gaps, inconsistencies and lack of coordination in areas such as the definition of aquatic nuisance species; handling, transport and reporting procedures; and the nature and focus of both regulatory and public information and education programs. Given the ecosystemic nature of ANS infestation problems, and the limited resources to address them, the Great Lakes Panel agreed that enhanced consistency between and among Great Lakes states, provinces, tribal authorities and other jurisdictions would ensure a more efficient and effective regional prevention and control program."

Legislation, Regulation and Policy for the Prevention and Control of Nonindigenous Aquatic Nuisance Species: Model Guidance for Great Lakes Jurisdictions Approved by the Great Lakes Panel on Aquatic Nuisance Species, June 1999

The Commission and the Great Lakes Fishery Commission (GLFC) raised this issue in a 1990 report to Governments, *Exotic Species and the Shipping Industry*. The report emphasized the need for a standardized, systematic, and impartial exploration of possible approaches to managing the urgent problems associated with the introduction of alien invasive species into the Great Lakes.

Current Status

The establishment of the Great Lakes Panel on Aquatic Nuisance Species, chartered under U.S. law, and the annual International Aquatic Nuisance Species Conference (Ninth at Duluth, Minnesota, 1999; Tenth at Toronto, Ontario, 2000) are notable binational and international efforts addressing this problem. The workshop at the Biennial Forum in Milwaukee provided an overview of the current policy status. The workshop concluded that there are no easy solutions to the challenge of preventing new introductions of AIS. However, there was widespread agreement on the need for a definite standard on the allowable discharge of ballast water. Also, there are no simple ways to cope effectively with those AIS already living in the Great Lakes basin. The Great Lakes Panel noted that greater interjurisdictional consistency would lead to greater efficiency and effectiveness.

Current Control Framework

Fortunately for Canada and the United States, geography has helped to ensure coordinated enforcement of the existing AIS legislation. Vessels entering the Great Lakes must pass through five Canadian locks before entering U.S. waters. Joint boardings by Canadian and U.S. inspectors, which initially took place only in Massena, New York, are now also taking place in Montreal, Quebec.

The two countries have a similar approach to preventing the introduction of AIS by requiring ballast water exchange. The U.S. National Invasive Species Act of 1996 (NISA 96) adopts a regulatory approach. Canada has "Voluntary Guidelines for the Control of Ballast Water Discharges from Ships Proceeding to the St. Lawrence River and Great Lakes." However, strict penalties apply for false reporting of compliance with these guidelines. The two nations are both working with the International Maritime Organization in developing international standards.

Challenge of No Ballast on Board Vessels

Perhaps of most concern, as a source of alien invasive species, are vessels classified as "no ballast on board" (NOBOB). Neither the U.S. legislation nor the Canadian guidelines apply under these circumstances. Although they are not carrying ballast water, these vessels carry residual sediment in their ballast tanks that can harbor active and dormant species. These AIS can escape from a ship that unloads cargo in a Great Lakes port and takes on ballast water to travel to another Great Lakes port. Before loading at this second port, the vessel releases its ballast water, which is now a mixture of residual sediment and Great Lakes water. Whatever organisms were present in the tanks may now become established in the ecosystem.

Inadequate Current Practices

The Commission believes that the existing legislation and resulting practices of both countries are inadequate to protect the Great Lakes from further introductions of AIS. Exchanging ballast water on the high seas poses risks to the vessel and the crew. The Governments should continue to work closely with the shipping industry and the scientific community to develop a standard for discharges of ballast water and residual sediment, allowing

The Commission believes that the existing legislation and resulting practices of both countries are inadequate to protect the Great Lakes from further introductions of AIS.

industry to choose the most effective methodology that meets the standard. The standard must address controlling dormant individuals that, in particular, pose a risk because their resistance to stringent control measures makes them difficult to eradicate.

In previous correspondence to the Government of Canada, the Commission raised the possibility of establishing facilities in the lower St. Lawrence River to treat ballast water in a safe environment. This would include treatment of sediment in NOBOB tanks as well as more effective treatment of full ballast tanks. In addition to offering improved protection for the Great Lakes, such facilities could serve as a research laboratory for emerging ballast water treatment technologies. The Commission reminds the Parties of a November 1998 letter in which it drew the Parties' attention to a binational ballast water research strategy and plan described in the *1996-1997 Binational Progress Report on Protection of Great Lakes Water Quality* prepared by the agencies responsible for the Coast Guard Annexes. The Commission has not received a response to that letter nor has it been informed of the development of a research strategy. The Commission further notes that a possible facility for on-board treatment of ballast water and residual sediment in the lower St. Lawrence River could form part of such a strategy. The Parties should also implement the proposed research strategy in order to realize the benefits of binational coordination on ballast water research.

Other Sources of AIS

The AIS issue related to nonvessel introductions, such as those from aquaculture, bait fish trade, and aquarium industries, also requires careful attention. There is a threat that AIS may escape from the activities of these industries and subsequently become established in the basin. Recreational boating and fishing also play a role by spreading species geographically within the basin.

The Great Lakes Water Quality Board and the Great Lakes Fishery Commission produced the report *Addressing Concerns for Water Quality Impacts from Large-Scale Great Lakes Aquaculture*, based on a meeting in Windsor, Ontario, in January 1999. The report findings related primarily to protecting water quality. Such practices as controlling feeding and proper site location to prevent the threat of an invasive species becoming established are aquaculture issues. Based upon this work, the Commission sees a need for the Parties to engage the industries, provinces, and states in a coordinated, binational effort to address the complete range of AIS issues, develop a plan of action, and implement an appropriate regulatory system. The Commission recognizes that there is little point in controlling one vector while allowing another to go unchecked.

THE COMMISSION RECOMMENDS THAT:

The Parties should take the following measures to deal with alien invasive species:

(i) adopt and implement the binational ballast water research strategy and plan described in the 1996-1997 Binational Progress Report on Protection of Great Lakes Water Quality,

(ii) give a Reference to the Commission to develop:

(a) binational standards that should be applied to discharges of ballast water, and

(b) recommendations on the most appropriate methods for implementing those standards including, for example, the possibility of on-board treatment of ballast water and residual ballast sediment and the possibility of establishing ballast water and residual ballast sediment treatment facilities in the lower St. Lawrence River.

Chapter 6
Information and Data Management

A fundamental obstacle to achieving the purposes and goals of the annexes of the Agreement relates to the availability and management of information and data. This is an overarching concern in the decision-making and policy formulation activities of the Agreement. Implicit in many of the Agreement annexes is the availability and accessibility of needed information, but such information is not always available. Several Commission-sponsored activities, ranging from the Indicators Implementation Task Force to work of the International Air Quality Advisory Board, have had problems obtaining information and data. The concerns expressed by these groups indicate the need for an information and data management policy specifically keyed to the Agreement.

What should such an information and data management policy contain? First, it should be binational and specifically formulated to serve the Agreement as well as many other needs. Second, it must recognize the different uses and sources of information and data, including the design, organization, and management of the repositories of the information and data, and the utilization of the information and data for effective decision-making and policy formulation.

An appropriate place to start the development of an information and data management policy is in the area of monitoring and surveillance. These activities provide a quantitative basis for assessing the state of an ecosystem. Monitoring and surveillance provide clues about the evolution and possible future development of the ecosystem, alert managers to emerging problems, and indicate whether a given program is making progress toward its assigned goals. Most Agreement annexes depend on monitoring programs to track implementation progress. The wide-ranging monitoring activities initiated under the Agreement share several common challenges such as funding, efficiency, and quality control/quality assurance.

6.1 Annex 11 - Surveillance and Monitoring

Monitoring and surveillance programs require careful design and implementation to assure high-quality data. In turn, the analysis and interpretation of these data must meet rigorous statistical and scientific standards. Monitoring is often an expensive undertaking. It is always necessary, usually repetitive, and sometimes tedious. The United States and Canada have amassed enough data overall to support the use of indicators in monitoring and surveillance programs. However, data collection, analysis, and reporting need improvement because of the nonuniform quality and the many gaps in existing data sets.

The Commission is greatly concerned that the Parties cannot fulfill their goals under the Agreement because they currently lack, and will lack for the foreseeable future, the full breadth and depth of programs to obtain the environmental monitoring information necessary to guide Agreement-related programs.

THE COMMISSION IS GREATLY CONCERNED THAT THE PARTIES CANNOT FULFILL THEIR GOALS UNDER THE AGREEMENT BECAUSE THEY CURRENTLY LACK, AND WILL LACK FOR THE FORESEEABLE FUTURE, THE FULL BREADTH AND DEPTH OF PROGRAMS TO OBTAIN THE ENVIRONMENTAL MONITORING INFORMATION NECESSARY TO GUIDE AGREEMENT-RELATED PROGRAMS.

Monitoring and surveillance have historically received low priority from both researchers and managers who decide which projects receive financial and other resources. Over the past five years, the funds allocated to monitoring in both the Unites States and Canada have declined considerably both in amount and in areas of coverage. Air quality monitoring may be the exception and the only activity that has received increased funding. Total funding for monitoring and surveillance is, however, declining steadily, and some researchers and managers are concerned that current programs will not be adequate to provide the information needed for regulatory and other programs.

THE COMMISSION RECOMMENDS THAT:

The Parties should develop and maintain the full range of monitoring and surveillance programs necessary to enable them to fulfill their commitments under the Great Lakes Water Quality Agreement.

Factors Inhibiting Access to Data and Information for Monitoring and Surveillance

The discussion of monitoring and surveillance and indicator reporting assumes that when data are collected they will be made available by the Parties for use and review by the Commission. Unfortunately, as the Indicators Implementation Task Force experienced, this is not always the case. Restrictions exist in both countries based on the confidentiality of industrial, census, and other proprietary data. In some cases, the data are licensed. Because of cost recovery policies in some agencies, and despite the Agreement's wording in Article IX(1) that data be available without restriction, the Commission must pay for the use of the data. In another example, the U.S. and Canadian census agencies collect data, but they only provide these data after some processing to ensure that individual sources remain anonymous. In other cases, the data are not provided because of corporate confidentiality agreements.

For many years, the Commission has requested that the Parties address the data availability issue. Some recent progress has been made through legislative and policy changes that remove some of the protection on data related to environmental contamination. Notable here are the toxic substances inventories of various kinds and community right-to-know laws. However, there are limitations associated with toxic substances inventories. The regulations under the laws only address chemicals that are discharged, manufactured, or used in commerce in excess of certain quantities, and they only apply to some sources that have gross receipts or capitalization levels above certain monetary values. The problem of data accessibility will only increase with the need for data that meet rigorous statistical tests for the implementation of indicators and for monitoring persistent toxic substances.

THE COMMISSION RECOMMENDS THAT:

The Parties should provide adequate access to data while protecting confidentiality agreements and waiving cost recovery policies that contradict the intent of Article IX of the Great Lakes Water Quality Agreement.

6.2 Data Management

Data Quality

Regulatory agencies require strong emphasis on quality assurance. This is important because in numerous court cases environmental problems have not been addressed because proponents could not demonstrate that data could pass the test of legal evidence. This has led to the view that the data must be capable of being defended in legal proceedings (*defensible*). It has also caused some agencies to disregard or ignore the research findings of other agencies because of perceived difficulties with quality assurance requirements and programs of these other agencies.

The Commission has noted that, over the years, the evolution of quality assurance to secure scientifically and legally defensible data for these other purposes has also resulted in significant increases in the value and credibility of the data supplied by the Parties under the Agreement. A good quality assurance program is a necessary part of any monitoring activity, including data and information management programs.

Trend Analysis

One use of surveillance and monitoring data is to analyze trends, but current programs have not made trend study a priority. This is somewhat surprising because, with the advances in mathematical statistics over the past 20 years, the statistical tools for trend analysis are readily accessible. Discerning trends, cycles, outliers, interventions, and system change characteristics has become relatively sophisticated. For example, effective time series studies can be performed when either or both time and distance intervals are nonuniform.

Comparability and Compatibility of Data

One problem that plagues decision-making is the incompatibility among various monitoring protocols used to provide information for systemwide decision-making. The Commission has long advocated that monitoring emphasize both comparable and compatible data. Comparability is achieved by measuring the same things in the same way, or by establishing that different measures of the same thing by different instruments, groups, or protocols are equivalent and thus can be used for comparison purposes. Compatible measurements are those that can be pooled for overall assessment because they come from the same statistical universe. Ecosystem integrity requires compatible data because of the integrative nature of the subject. Great strides have been made to assure comparable data, but problems related to compatible data remain largely unresolved. These concerns were addressed at a Commission-sponsored Workshop on Transboundary Monitoring in 1984. The concerns remain and were reiterated by the Indicators Implementation Task Force, which recommended improvements to data collection, analysis, and reporting.

THE COMMISSION RECOMMENDS THAT:

The Parties should correct existing problems with the collection, analyses and reporting of data, including establishing sampling protocols, filling data gaps and ensuring the quality of data.

6.3 Information Management

"One of the key ingredients missing from a serious attempt to increase the productivity of environmental protection efforts is the absence of agreed upon, valid environmental data upon which to base policy decisions."

Council of Great Lake Industries
Spring 2000 Newsletter

The application and interpretation of data generate information. Information forms the basis for policy decisions. Indicators are one type of information, but there are many others. Information management encompasses both information technology and data management. Information management has several dimensions, such as availability, organization, and application. Each of these dimensions has problems that concern the Commission because each affects the Parties' ability to meet their obligations under the Agreement as well as the Commission's ability to act as an objective adviser on how the Parties are meeting their obligations.

There has been an explosion in the information technology and management fields in the past ten years. The Commission, the Governments, and other organizations have active web sites on the Internet that provide a broad spectrum of information and services related to the Great Lakes. However, these efforts are ad hoc and not part of a coordinated policy on information management related to the Great Lakes Water Quality Agreement.

An enduring problem is the lack of an appropriate and readily accessible repository of information. Many of the technical problems of centralization are being addressed through the development of virtual data bases (meta data bases) with links to wherever the appropriate data and information are stored. Further technical advances in data base organization allow one to use linked data sets for statistical analyses and computer modeling. The Commission sees great potential for using these tools to organize Great Lakes environmental monitoring and surveillance data to provide a readily accessible repository.

In the *1997-99 Priorities Report*, the Great Lakes Science Advisory Board considered a coupled Great Lakes observation and modeling system. Board discussions emphasized the great strides made in information technology since the original signing of the Agreement, as well as some philosophical and practical issues that hampered the effectiveness of monitoring and surveillance in the 20th century.

The Board looked at the benefits of establishing a transboundary monitoring network, as first described at the Commission's 1984 Workshop on Transboundary Monitoring, and considered how such a network could be coupled with current technological advances to make the Board's vision a reality. The Board assessed modern field techniques involving satellite and GIS approaches, advanced instrumentation used by oceanographers and climatologists, the ever-increasing capability of computers, and modern advances in information technology. (IJC 1999)

Some of the existing monitoring and surveillance components, such as IADN, not only meet the vision but provide a potential pathway to the realization of many of its anticipated benefits. These include continuous monitoring capabilities during extreme climatological events (often missed in the analysis of environmental effects), improved capabilities to design and undertake lakewide management strategies, the integration of weather satellite data and lake data on a time- and location-specific basis, increased data and information sharing, and greater cost and operational efficiencies in the use of research vessels and the scheduling of crews.

The Science Advisory Board recommended that the Commission promote information technology applications on a high-priority basis for better management and binational cooperation for the Great Lakes (IJC 1999). The Commission considers this Board recommendation as the basis for the development of an information management policy under the Agreement, one that goes beyond the many useful Internet sites that provide information, publications, and other kinds of access to Great Lakes information.

THE COMMISSION RECOMMENDS THAT:

The Parties should, within two years, develop and implement a binational information policy employing advanced technology to support implementation of the Great Lakes Water Quality Agreement. This policy should include provision for:

(i) accessibility of data and information,

(ii) organization and management of data bases,

(iii) protocols to ensure compatibility and comparability of data for weight of evidence and ecosystem integrity analysis,

(iv) support of indicator development, particularly indicators that support the goals of drinkability, swimmability, and edibility of fish, and

(v) principles for evaluating information for decision-making.

CHAPTER 7
INDICATORS AND SOLEC

Monitoring and surveillance programs have logistic and economic constraints. These programs cannot measure all the parameters desired to assess progress under the Agreement. Indicators offer a means of tracking progress and provide integration of data and information. However, indicators will only be as good as the data used to develop them.

There are two parallel and complementary activities addressing ecosystem indicators under the Agreement. In 1992, the Parties established the State of the Lakes Ecosystem Conference (SOLEC) to develop comprehensive, binational reports on the environmental condition of the lakes in order to measure progress under the Agreement. An information and data management policy would assist SOLEC and the Commission by providing a framework for the development of indicators for monitoring and other related needs.

The 1998 SOLEC conference began working on a group of 80 indicators intended to characterize the condition of ecosystem components, to identify stresses to the ecosystem, and to guide program responses. The Parties intend to report on these indicators every two years to inform the public and assess progress in achieving the purpose of the Agreement. The proposed approach for SOLEC 2000, to group the indicators into compartments by issue and major topic, should result in more meaningful and useful information.

The Commission's Indicators Evaluation Task Force's 1996 Report, *Indicators to Evaluate Progress under the Great Lakes Water Quality Agreement*, proposed a framework for indicators based on nine Desired Outcomes, in part derived from Annex 2 of the Agreement (RAPs and LaMPs). Subsequently, in 1996, the Commission established the Indicators Implementation Task Force (IITF) to advise on obtaining the required data and information to support the nine Desired Outcomes and to investigate the feasibility of using the indicators to assess the Parties'

progress under the Agreement. The Task Force final report, provided to the Commission in early 2000, recommended that indicators be developed for three Desired Outcomes: water in which it is safe to swim, water that is safe to drink, and fish that are safe to eat. These are called the "swimmability, drinkability, fish edibility" outcomes. (Indicators Implementation Task Force 2000)

INDICATORS WILL ONLY BE AS GOOD AS THE DATA USED TO DEVELOP THEM.

According to the IITF, there appears to be enough data available to proceed with indicators measuring the three Desired Outcomes of swimmability, drinkability and fish edibility. Consequently, the Commission would like to see a field trial at an appropriate location and of appropriate scale to test these indicators. The Commission has sufficient confidence in the success of this field test that it believes such a trial can occur concurrently with the adoption of these indicators. Reporting on the field test and the adoption of the indicators should occur at SOLEC 2000.

Although reporting on these three designated Desired Outcomes is an important beginning, work in other key areas of the Agreement must continue. Foremost among these is the development of indicators to support the Desired Outcome of virtual elimination of inputs of persistent toxic substances.

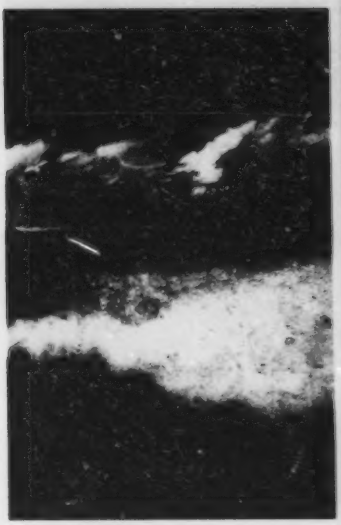
Growing concern about the impact of land use on water quality, as addressed in Chapter 4, points to the need to track the three components of the Desired Outcome of physical environmental integrity. These components include wetlands, groundwater, and land use, and they will support work under Annex 13 (Pollution from Nonpoint Sources). An indicator for stream base flow would provide much needed information on groundwater as well as complement activities under Annex 16 (Pollution from Contaminated Groundwater). (U.S. Geological Survey 1998)

THE COMMISSION RECOMMENDS THAT:

The Parties should report on indicators for the three Desired Outcomes of drinkability, swimmability and fish edibility beginning with the SOLEC 2000 conference and biennially thereafter.

The Parties should report on indicators for the Desired Outcome of virtual elimination of inputs of persistent toxic substances beginning with the SOLEC 2002 conference and biennially thereafter.

The Parties should develop and report on three specific indicators for the Desired Outcome of physical environment integrity beginning with the SOLEC 2002 conference and biennially thereafter.



CHAPTER 8
OTHER ISSUES

8.1 Issues Raised by the Public

The Commission encourages public input and comment at all Great Lakes meetings and events in which it participates. It also invites formal submissions at Commission meetings. With the importance of the Great Lakes to citizens and the broad significance of the Agreement, many local concerns are often relevant, or perceived to be relevant, to water quality throughout the basin. Even when issues fall within other mandates and authorities, the Commission nonetheless appreciates the opportunity to consider such concerns within the context of the Agreement. Some of the ongoing concerns referenced in past reports include underwater timber salvage, lake bed mineral exploration, the diffusion of genetically modified organisms, loss of biodiversity and habitat, and the storage of nuclear waste casks on Lake Michigan shores. Current issues brought to the attention of the Commission include the following:

- Crandon Mine - a proposed copper, zinc, and lead mining development near Crandon, Wisconsin, with the potential to contaminate groundwater and interbasin water transfers from the Great Lakes basin.

- The destruction of natural habitat in Great Lakes tributaries, through such measures as eliminating waterfalls in order to improve habitat for nonnative sport fish.

- The mining of Great Lakes sand dunes and the loss of this unique nonrenewable ecological resource.

- The impact of nuclear reactors, and their decommissioning, in the Great Lakes basin.

8.2 Involvement of Local Governments

A particularly noteworthy event for the Commission is the annual International Great Lakes / St. Lawrence Mayors Conference. At the 1997 conference in Toledo, Ohio, a resolution was passed regarding healthy beaches, which provided a reference point for the development of an indicator based on the desired outcome of swimmability, as previously mentioned. In 1998 the conference was held in Windsor, Ontario, and included sessions addressing water quality and level issues, climate change, and management of contaminated sediment. The 1999 meeting in Montreal included a session on water quality and also discussed the water export issue. At its most recent conference in Gary, Indiana, the Great Lakes mayors passed a number of resolutions which address water quality and quantity concerns including the need to: renew the Canada-Ontario Agreement, develop appropriate ballast water standards and best management practices, support increased funding for Great Lakes cleanup and research, and assess and mitigate the impacts of persistent low water levels.

The Biennial Forum in Milwaukee also included a workshop on municipal issues, focusing on the impact of land use on water quality. The growing involvement and interest of local governments in Great Lakes issues is significant for progress under the Agreement. With devolution, the involvement of citizens in cleanup efforts, and the development of key partnerships that support implementation and decision-making, local governments are playing an increasingly important role in implementing Great Lakes programs. An emerging institutional challenge for the Parties is to encourage and sustain this interest further by strengthening the mechanisms through which local governments can participate in Agreement activities.

8.3 Response of Governments to Commission Recommendations

The Commission recognizes the effort involved in compiling responses to biennial report recommendations. The Canadian Government gave its response at the Biennial Forum in Milwaukee in September 1999. The United States gave its response a few weeks later, referring to the *1999 Biennial Progress Report to the IJC* which, as of the time of this 10th Biennial Report remains unavailable. However, the Commission is concerned that neither Government's response has been timely or complete. The Commission reminds the Parties that the timeliness and completeness of their responses to Commission recommendations and their progress reports reflect their commitment to the Agreement and their willingness to be open and transparent to the public.

Conclusions and Recommendations

When the state of the Great Lakes is discussed, two questions are frequently asked: Are the lakes improving, and what progress are the Parties to the Agreement achieving through their programs? It is difficult to respond to these questions simply. Certainly the lakes are less polluted now than they were 25 years ago. However, with increased understanding of sources and pathways and of health effects associated with critical pollutants, it is apparent that pollution levels are still too high. Furthermore, acceptable levels will not be achieved in the near future given current programs and the resources dedicated to them.

"The Agreement should be maintained, implemented, and lived up to by both governments to ensure the protection and quality of our sweetwater seas. Labor unions, First Nations, environmental activists, governments and industry must work together to ensure the health and safety of our Great lakes, a precious natural resource which we all love so dearly."

Don Amortand
United Auto Workers Union

In this report, the Commission has identified several key actions and remedies which, if adopted, can alter the otherwise inevitable maintenance of the *status quo*. These recommendations are feasible to implement and are sensible approaches from the point of view of both policy and management. Failure to address the challenge of restoration during this time of economic prosperity will result in future generations of Great Lakes citizens inheriting the consequences of our inaction.

Remedial Action Plans

Given the public's right to know the achievements in each AOC and what actions to expect in the future, the Parties should prepare a consolidated report on RAP progress that lists the accomplishments to date, funds expended, what remains to be done and the funds and timing required to finish the necessary work. Governments must clearly state what role they will be playing with each AOC and what resources they will be dedicating to restoring the impaired beneficial uses.

Threat to Human Health

Governments should require that:

(i) sport fish consumption advisories state plainly that eating Great Lakes sport fish may lead to birth anomalies and other serious health problems for children and women of child-bearing age. These advisories should be addressed and distributed directly to women, in addition to their general distribution,

(ii) consumption advisories clearly identify fish to be totally avoided in light of the precautionary approach, and preparation methods for any that may be consumed, and

(iii) consumption advisories are supported by culturally appropriate community education programs directed to those who are likely to consume these fish.

Contaminated Sediment

Governments should immediately develop a comprehensive, binational program to address the full scope of the contaminated sediments problem over the long term, setting appropriate priorities and defining the resources required for completion. As part of this comprehensive program, governments should ensure that:

(i) programs and cost estimates are in place and made public for fully addressing contaminated sediments in Areas of Concern,

(ii) timetables for fully implementing those programs are established and made public,

(iii) resources are provided to fully implement the programs in accordance with the established timetables, and

(iv) progress reports are issued at least biennially.

Airborne Toxic Substances

The Parties should take the following measures to deal with airborne pollutants:

(i) identify both in-basin and out-of-basin sources of atmospheric deposition of persistent toxic substances to the Great Lakes, quantify their contribution to the total burden of these substances to the lakes, and use this information to formulate and implement appropriate prevention and control measures; and

(ii) adopt a source-receptor computer model, improve emissions inventory information, and add dioxin and mercury to the Integrated Atmospheric Deposition Network to improve the data bases for these two substances.

Great Lakes Binational Toxics Strategy

The Parties should strengthen the Great Lakes Binational Toxics Strategy by fully addressing all sources of persistent toxic substances, such as atmospheric transport and deposition and *in situ* contaminants in sediments. In order to include the air pathway the Parties should:

i) establish an inventory of baseline air emissions for toxics for all of the United States and Canada

ii) undertake a complete analysis of emission reduction scenarios for key source regions and determine their effectiveness in reducing contamination of the Great Lakes from the air.

The Parties should ensure that the Strategy is truly both strategic and binational by strengthening the integration and priority-setting component and establishing a full-time binational secretariat.

Land Use

The Governments should provide for a binational study of the effects of changes in land use on Great Lakes water quality to determine the measures that should be taken to address these changes, including:

(i) the effects of urban and residential growth,

(ii) the effectiveness of existing policies and programs in controlling pollution from land use in all sectors, and

(iii) the identification of measures that should be taken by provincial and state governments, with appropriate assistance from the Parties, to prevent adverse effects.

Governments should proceed with implementation of the SOLEC work on Biodiversity Investment Areas, emphasizing the preservation and rehabilitation of wetlands.

Alien Invasive Species

The Parties should take the following measures to deal with alien invasive species:

(i) adopt and implement the binational ballast water research strategy and plan described in the 1996-1997 Binational Progress Report on Protection of Great Lakes Water Quality,

(ii) give a Reference to the Commission to develop:

(a) binational standards that should be applied to discharges of ballast water, and

(b) recommendations on the most appropriate methods for implementing those standards including, for example, the possibility of on-board treatment of ballast water and residual ballast sediment and the possibility of establishing ballast water and residual ballast sediment treatment facilities in the lower St. Lawrence River.

Information and Data Management

The Parties should develop and maintain the full range of monitoring and surveillance programs necessary to enable them to fulfill their commitments under the Great Lakes Water Quality Agreement.

The Parties should provide adequate access to data while protecting confidentiality agreements and waiving cost recovery policies that contradict the intent of Article IX of the Great Lakes Water Quality Agreement.

The Parties should correct existing problems with the collection, analyses and reporting of data, including establishing sampling protocols, filling data gaps and ensuring the quality of data.

The Parties should, within two years, develop and implement a binational information policy employing advanced technology to support implementation of the Great Lakes Water Quality Agreement. This policy should include provision for:

(i) accessibility of data and information,

(ii) organization and management of data bases,

(iii) protocols to ensure compatibility and comparability of data for weight of evidence and ecosystem integrity analysis,

(iv) support of indicator development, and particularly indicators that support the goals of drinkability, swimmability, and edibility of fish, and

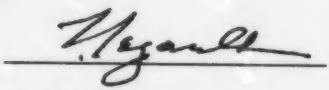
(v) principles for evaluating information for decision-making.

SOLEC and Indicators

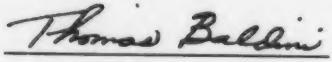
The Parties should report on indicators for the three Desired Outcomes of drinkability, swimmability and fish edibility beginning with the SOLEC 2000 conference and biennially thereafter.

The Parties should report on indicators for the Desired Outcome of virtual elimination of inputs of persistent toxic substances beginning with the SOLEC 2002 conference and biennially thereafter.

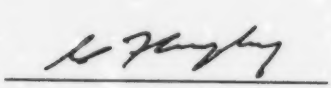
The Parties should develop and report on three specific indicators for the Desired Outcome of physical environment integrity beginning with the SOLEC 2002 conference and biennially thereafter.



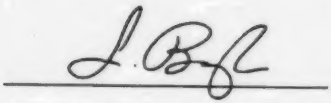
L. H. Legault
Canadian Chairman



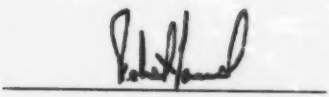
Thomas L. Baldini
United States Chairman



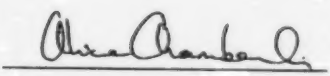
C. Francis Murphy
Commissioner



Susan B. Bayh
Commissioner



Robert Gourd
Commissioner



Alice Chamberlin
Commissioner

APPENDIX A

1997-1999 PUBLIC CONSULTATION ACTIVITIES, WORKSHOPS AND REPORTS ISSUED WITH RESPECT TO GREAT LAKES WATER QUALITY

1999 GREAT LAKES WATER QUALITY FORUM, MILWAUKEE WISCONSIN

The program for the 1999 Great Lakes Water Quality Forum in Milwaukee emphasized dialogue among the participants. In plenary sessions, the public commented on a variety of issues, notably RAPs and LaMPs, funding issues, development of indicators under SOLEC, and sediment cleanup. Several technical workshops provided substantial opportunities for exchange of ideas, dialogue, public outreach and obtaining public input. These workshops assembled scientific specialists, government and environmental group officials, and concerned citizens to address such topics as air quality modeling for toxic substances, alien invasive species, and ways in which technical specialists can communicate complex scientific information for public use. These workshops allowed for informed discussion among all participants including Commissioners. The Commission intends to continue the emphasis on topical sessions in planning its next biennial meeting in Montreal in September 2001.

While the workshop focus reduced the number of individual presentations made during the public hearing component, compared to other biennial meetings, the quality of the presentations was excellent and there was greater opportunity for interaction between the speakers and Commissioners. The Commission heard statements presented by the leadership of most of the public groups and organizations involved in Great Lakes activities. Their comments were binational in focus, and addressed a range of concerns including RAP progress, funding issues, matters of accountability and reporting under the Agreement, and emerging issues.

PUBLIC CONSULTATION

1. **September 1997. Area of Concern site visit. SAB public meeting. Co-hosted with Mohawk Council of Akwesasne, Cornwall, ON. http://www.ijc.org/boards/sab/pr9799/rapvisit.html**
2. **November 1997. Area of Concern site visit. SAB public meeting regarding the St. Marys River Status Assessment. Sault Sainte Marie, MI. http://www.ijc.org/boards/sab/pr9799/rapvisit.html**
3. **September 1998. Area of Concern site visit. SAB public meeting. Porter/Gary/ Hammond, IN. http://www.ijc.org/boards/sab/pr9799/rapvisit.html**

4. **October 1998. WQB public meeting and symposium, Lorain, OH. *Protecting What Has Been Gained in the Black River.* Co-hosted with the Black River RAP Coordinating Committee. http://www.ijc.org/boards/wqb/black/toc.html**
5. **November 1998. Council of Great Lakes Research Managers public meeting, Ann Arbor, MI.**
6. **May 1999. WQB public meeting and symposium, Toronto, ON. *Toward a Watershed Monitoring Framework for the Toronto Region.* http://www.ijc.org/boards/wqb/toronto/index.html**
7. **September 1999. Public workshop on *Air Pollutant Deposition to the Great Lakes*, Milwaukee, WI. http://www.ijc.org/boards/iaqab/index.html**
8. **September 1999. 1999 Great Lakes Water Quality Forum, Milwaukee, WI. http://www.ijc.org/milwaukee/index.html**

REMEDIAL ACTION PLANS AND LAKEWIDE MANAGEMENT PLANS

9. **February 1998. SAB *Meeting to Assess Scientific Issues in Relation to Lakewide Management Plans*. Windsor, ON. http://www.ijc.org/boards/sab/pr9799/specmeet.html**
10. **March 1998. *Beacons of Light Successful Strategies Toward Restoration in Areas of Concern.* http://www.ijc.org/boards/annex2/beacon/beacon.html**
11. **September 1998. *RAP Workshop on Transferring Successful Strategies and Techniques*, Hammond IN.**
12. **October 1998. *Nipigon Bay Area of Concern Stage 1 Review.* http://www.ijc.org/boards/annex2/nipigon/stage2rev.html**
13. **October 1998. WQB Sediment Priority Action Committee members participated in a Muskegon and White Lake RAP conference titled "Cleaning Up Our Lakes, Rivers, and Streams." Muskegon, MI.**
14. **February 1999. *St. Marys River Area of Concern Status Assessment.* http://www.ijc.org/comm/stmarys/status.html**
15. **May 1999. Roundtable discussion, based on the question, *"Does the Recent Trend of Fewer Government Resources have a Bearing on Delivery of RAPs and LaMPs?"* Toronto, ON**
16. **October 1999. Lake Ontario Lakewide Management Plan Stage 1 Review. http://www.ijc.org/comm/lostage1.html**

17. **December 1999.** ***Hamilton Harbour Area of Concern Status Assessment.*** **http://www.ijc.org/comm/hamhar/hamharsa.html**

18. **December 1999.** ***Hamilton Harbour Area of Concern Stage 2 Review.*** **http://www.ijc.org/boards/annex2/hhrap2.html**

INDICATORS

19. **May 1998.** ***Great Lakes Habitat Restoration and Conservation.*** **A poster session and presentation at IAGLR '98, Hamilton, Ontario. http://www.ijc.org/boards/iitf/pr9799/activities.html**

20. **June 1998.** ***Indicators of the Condition of the Great Lakes Basin Ecosystem - A Binational Workshop,*** **Windsor, ON. http://www.ijc.org/boards/iitf/pr9799/activities.html**

21. **July 1998.** ***IITF Progress Report.*** **http://www.ijc.org/boards/iitf/prog0798.html**

22. **July 1998. Commissioner Alice Chamberlin spoke on behalf of the Task Force and a poster session was held at the Great Lakes/St. Lawrence Mayors Conference. Windsor, ON.**

23. **October 1998.** ***Workshop on Indicators*** **at SOLEC '98, Buffalo, NY. http://www.ijc.org/boards/iitf/pr9799/activities.html**

24. **May 1999. Presentation at IAGLR '99, Cleveland, OH. http://www.ijc.org/boards/iitf/pr9799/activities.html**

25. **August 1999.** ***Implementing Indicators for Human Health. Workshop for Drinking Water,*** **sponsored by SOLEC and IITF.**

26. **March 2000,** ***Indicators Implementation Task Force, Final Report***

SCIENCE AND RESEARCH

27. **1998 and 1999 Great Lakes - St. Lawrence Research Inventory, on-going each year.**

    1998 - http://www.ijc.org/cglrm/ri98home.html

    1999 - http://www.ijc.org/cglrm/ri99home.html

28. **March 1998.** ***Second Annual Great Lakes Research Vessel Coordination Workshop,*** **Ann Arbor, MI.**

29. **1998.** ***Great Lakes Research Vessel Inventory.*** **http://www.ijc.org/boards/cglr/rv/vessels.html**

30. **1998 survey,** ***Identifying Emerging Issues in the Great Lakes,*** **SAB Workgroup on Emerging Issues.**

31. **February 1999.** ***Third Annual Great Lakes Research Vessel Workshop*****, Windsor, ON.**

32. **May 1999. CGLRM and WQB co-assisted in the symposium** ***The Decline of Great Lakes Monitoring: Causes and Solutions.*** **IAGLR '99, Cleveland, OH.**

AIR

33. **November 1998.** ***Special Report on Transboundary Air Quality Issues.*** **http://www.ijc.org/boards/iaqab/spectrans/cover.html**

34. **May 1999.** ***24th Progress Report to the International Joint Commission.*** **http://www.ijc.org/boards/iaqab/progress24/**

35. **October 1999. WQB and IAQAB co-sponsored a workshop on regulating point sources of air contaminants based on Great Lakes water quality standards and violations.**

HABITAT

36. **March 1998. CGLRM and WQB co-sponsored** ***Rehabilitating and Conserving Detroit River Habitats.***
http://www.netcore.ca/~rspring/cea-drhc/cover.html

LAKE ERIE

37. **April 1999. CGLRM and WQB co-sponsored the** ***Lake Erie at the Millennium*** **conference, Windsor, ON.**
http://www.ijc.org/boards/cglr/erie2000.html

SEDIMENT

38. **April 1998.** ***Sediment Remediation Case Studies.*** **Three case studies of environmental benefits of sediment remediation are examined. http://www.ijc.org/boards/wqb/cases/studies.html**

39. ***Identifying and Assessing the Economic Benefits of Contaminated Aquatic Sediment Cleanup.***
http://www.ijc.org/publications/ecben.pdf

40. **July 1998. CGLRM and GLWQB co-reported on the** ***Management of Contaminated Sediments in the Great Lakes Basin and Benefits of Action,*** **to the Great Lakes/St. Lawrence Mayors Conference. Windsor, ON.**

41. **December 1998. CGLRM and WQB co-sponsored and convened by the Sediment Priority Action Committee, *Workshop to Evaluate Data Interpretation Tools Used to Make Sediment Management Decisions*, Windsor, ON.**
http://www.ijc.org/boards/wqb/sedwkshp/index.html

42. **September 1999. *Ecological Benefits of Contaminated Sediment Remediation in the Great Lakes Basin.* Sediment Priority Action Committee. http://www.ijc.org/boards/wqb/ecolsed/index.html**

MODELING

43. **October 1998. CGLRM session, *Connecting Ecosystem Objectives and Indicators through Modelling*, held at SOLEC, Buffalo, NY.**
http://www.ijc.org/boards/cglr/pr9799/priorities.html

44. **May 1999. *Great Lakes Modeling Summit*, held at the 42nd Conference on Great Lakes Research, Cleveland, OH.**
http://www.ijc.org/boards/cglr/index.html

BIODIVERSITY

45. **1998. Great Lakes Biodiversity Survey.**
http://www.ijc.org/boards/cglr/pr9799/priorities.html

PERSISTENT TOXIC SUBSTANCES

46. **September 1997. Workshop on *Policy Implications of Evidence Regarding Persistent Toxic Substances and Human Health*, Racine, WI. http://www.ijc.org/boards/sab/policy.html**

47. **March 1998. SAB workshop on *Water Quality Criteria in Relation to Health Effects of Persistent Toxic Substances*. Chicago, IL.**
http://www.ijc.org/boards/sab/pr9799/wqwork.html

    An article titled "Water Quality Objectives: Yardsticks of the GLWQA" was published in *Environmental Health Perspectives* in March 1999.
    http://ehpnet1.niehs.nih.gov/docs/1999/107-3/gilbertson-full.html

48. **March 1998. *Trends in the Levels and Effects of Persistent Toxic Substances in the Great Lakes.* Abstracts based on a 1996 SAB workshop on Environmental Results, Windsor, ON.**
http://www.ijc.org/boards/sab/ehwptstrends.html

49. **June 1998. WQB members participated in the Great Lakes Workshop as part of review of progress in control and management of persistent toxic substances. Chicago, IL.**

RADIOACTIVITY

50. **December 1997. Inventory of Radionuclindes for the Great Lakes. http://www.ijc.org/boards/nuclear/invrep/index.html**

51. **Fall 1999. *Report of Bioaccumulation of Elements to Accompany the Inventory of Radionuclides in the Great Lakes Basin.* http://www.ijc.org/boards/nuclear/bio/index.html**

NONPOINT SOURCE POLLUTION

52. **September 1998. SAB session on nonpoint sources of pollution held in association with the Great Lakes Soil Erosion and Sediment Control Conference, Toledo, OH. http://www.ijc.org/boards/sab/pr9799/nonpoint.html**

AQUACULTURE

53. **January 1999. *Aquaculture Roundtable: Addressing Concerns for Water Quality Impacts from Large Scale Great Lakes Aquaculture.* Roundtable meeting with the Habitat Advisory Board of the Great Lakes Fishery Commission. Windsor, ON. http://www.ijc.org/boards/wqb/aquaculture/index.html**

GOVERNMENT RESOURCES

54. **October 1998. *Review of Government Resources and Changing Program Thrusts as they Relate to Delivery of Programs under the Great Lakes Water Quality Agreement.* http://www.ijc.org/boards/wqb/govres/review.html**

BOARD AND COUNCIL PRIORITIES

55. **September 1999. *1997-99 Priorities and Progress Under the Great Lakes Water Quality Agreement.* http://www.ijc.org/comm/pr9799.html**

APPENDIX B
STUDIES ON FINDINGS IN HUMAN POPULATIONS

A Quarter Century of Research Progress on Reproductive and Developmental Effects of Persistent Toxic Substances from Great Lakes Fish Consumption

Year	Endpoints and Findings	Reference
1974 - Establishment of Lake Michigan Fish-eaters Cohort	Exposure study - PCB levels in breast milk and maternal serum correlates with consumption of Great Lakes fish.	Humphrey 1983
1980 - Establishment of Michigan Infant Cohort - Perinatal Studies	Exposure study - Lake Michigan sport fish consumption predicts PCBs in maternal milk and serum. Placental transfer of PCBs.	Schwartz et al. 1983 Jacobson et al. 1984a
	PCBs pose a risk to the fetus and newborn.	Jacobson et al. 1983
	Fish consumption and cord blood PCB predicts lower birth weight, smaller head circumference, and shorter gestational age.	Fein et al. 1984
	Contaminated fish consumption predicted motonc immaturity, poorer lability of states, a greater amount of startle, and more abnormally weak reflexes (classified as "wornsome").	Jacobson et al. 1984b
1981 - Michigan Infant Cohort - 7 months	Prenatal exposure to PCBs, measured as maternal consumption of Lake Michigan fish and cord blood PCB levels, predict a decrease in visual recognition memory. Indication of deficit in short term memory.	Jacobson et al. 1985a
1985 - Michigan Infant Cohort - 4 years	Serum samples from 4 year old children indicated breast feeding as a principal source of PCBs and PBBs, though eating fish also resulted in elevated levels.	Jacobson et al. 1985b
1985 - Michigan Infant Cohort - 4 years	Pre-natal exposure to PCBs predicted poorer short-term memory function on both verbal and quantitative tests indicating continuing impact.	Jacobson et al. 1990a
	Similarly, predicted growth retardation, but contemporary PCB levels predicted reduced activity levels.	Jacobson et al. 1990b
1991 - Michigan Infant Cohort - 11 years	Prenatal exposure to PCBs was associated with lower Intelligence Quotients (IQ) scores. Strongest effect was on memory and attention indicating fetal brain is particularly sensitive to these compounds.	Jacobson and Jacobson 1996

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Fein, G.G., J.L. Jacobson, S.W. Jacobson, P.M. Schwartz and J.K. Dowler. 1984. Prenatal exposure to polychlorinated biphenyls: Effects on birth size and gestational age. Journal of Pediatrics. 105:315-320.

Humphrey, H.E.B. 1983. Population studies of PCBs in Michigan residents. In F.M. D'Itri and M.A. Kamrin (Eds). PCBs: Human and Environmental Hazards. Butterworth, Boston, MA pp 299-310.

Jacobson, J.L., S.W. Jacobson, P.M. Schwartz, G.G. Fein. 1983. Intrauterine exposure of human newborns to PCBs: Measures of exposure. In F.M. D'Itri and M.A. Kamrin (Eds). PCBs: Human and Environmental Hazards. Butterworth, Boston, MA pp 311-343.

Jacobson, J.L., G.G. Fein, S.W. Jacobson, P.M. Schwartz and J.K. Dowler. 1984a. The transfer of polychlorinated biphenyls (PCBs) and polybrominated biphenyls (PBBs) across the human placenta and into maternal milk. American Journal of Public Health 74:378-379.

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APPENDIX C
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